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Hazardous Waste Ground-Water Task Force

Evaluation of Wyman-Gordon Company North Grafton, Massachusetts

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

The Commonwealth of Massachusetts
DEPARTMENT OF ENVIRONMENTAL
QUALITY ENGINEERING

HAZARDOUS WASTE GROUND-WATER TASK FORCE

Evaluation of Wyman-Gordon Company

(July 1988)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

UPDATE OF THE HAZARDOUS WASTE GROUND-WATER TASK FORCE EVALUATION OF WYMAN-GORDON COMPANY

The United States Environmental Protection Agency's Hazardous Waste Ground-Water Task Force ("Task Force"), in conjunction with the Massachusetts Department of Environmental Quality Engineering (MDEQE), conducted an evaluation at the Wyman-Gordon Company's hazardous waste disposal facility in North Grafton, Massachusetts. The evaluation consisted of an on-site field inspection conducted from July 22 through July 24, 1986. Wyman-Gordon was the 30th of 58 facilities to be evaluated by the Task Force. This update briefly outlines the current status of the Wyman-Gordon facility.

In April 1987, Wyman-Gordon submitted a Supplemental Well Installations and Hydrogeologic Evaluation Report to EPA and MDEQE. The purpose of the report was to outline the following:

- o Installation of additional wells to further define the eastern extent of the Rinsewater Treatment Facility (RTF) lagoons influence on ground water,
- o Drilling and installation of an additional bedrock well downgradient of the RTF lagoons to verify the hydraulic characteristics and vertical hydraulic gradients of the bedrock zone, and concentrations of lagoon constituents within the bedrock zone.

MDEQE reviewed the April 1987 Supplemental Report outlined above and concluded that even if Wyman-Gordon installed the proposed wells, inadequacies would exist in Wyman-Gordon's ground-water quality assessment program. These inadequacies are as follows:

(1) Wyman-Gordon has failed to adequately characterize and evaluate the hydrogeology, specifically the vertical ground-water flow gradients, between the RTF lagoons and East Brook.

(2) Wyman-Gordon has failed to adequately define the extent and concentration of the contaminant plume between the RTF lagoons and East Brook.

(3) Wyman-Gordon has failed to obtain samples from an adequate number of monitoring wells and environmental receptors, and to determine background concentrations required pursuant to 40 CFR 265.93 (d)(4) on a quarterly basis, as required by 40 CFR 265.93 (d) (7);

(4) Wyman-Gordon did not submit an annual report by March 1, 1987, as required by 40 CFR 265.94 (b).

On September 27, 1987, MDEQE issued an administrative compliance order to Wyman-Gordon (Docket No. HW87-35) for the ground-water monitoring violations that were discovered as a result of the facility evaluation, in addition to other violations. The ground-water monitoring violations cited are as follows:

- 40 CFR 265.93(b), (c), and (d) -- Prior to instituting a ground-water quality assessment program pursuant to 265.93(d), Wyman-Gordon neither performed the statistical analysis required under 265.93(b) and (c), nor specifically confirmed its operative assumption that the facility may be affecting ground-water quality.

- 40 CFR 265.93 (d)(7) -- Wyman-Gordon failed to sample and analyze a sufficient number of wells to make the determinations required under 265.93(d)(4), as required by 265.93(d)(7). The facility sampled and analyzed only one well during each quarter of 1985 and only two wells during the first two quarters of 1986.

- 40 CFR 265.94 (b) -- Wyman-Gordon failed to submit any ground-water monitoring reports after July 1986.

The compliance order also cited the Task Force's general inspection findings as follows:

> Wyman-Gordon's ground-water quality assessment program is not adequate to assess the rate, extent and concentration of hazardous waste constituents in ground water. The Task Force

inspection team specifically determined that additional wells were required to be installed in order to better characterize the facility, particularly the vertical components of flow in both the surficial unconsolidated sediments and bedrock portions of the aquifer. In addition, the Task Force identified other deficiencies in the program that the order requires to be addressed. The facility needs to implement:

A) A quarterly monitoring program which includes the sampling of a number of surface and ground-water points at the boundaries and within the plume of contamination and at any environmental receptors sufficient to define the rate of migration of the contaminant plume;

B) A sampling program which includes sampling of a number of parameters sufficient to define the composition of the contaminant plume;

C) Procedures for the collection of ground-water elevations from all wells and the stream elevation on a quarterly basis;

D) A characterization program to determine the geologic character of the bedrock underlying the facility and whether the bedrock is part of the uppermost aquifer;

E) A characterization program to determine the direction and magnitude of vertical ground-water flow gradients in the bedrock and unconsolidated deposits between the RTF Lagoons and East Brook;

F) The assessment of the extent and vertical distribution of contamination east of the RTF Lagoons.

Wyman-Gordon is currently not pursuing an operating permit for the RTF lagoons. Instead, they have submitted a closure plan for the RTF lagoons which was approved by the MDEQE. In addition, U.S. EPA has conducted a RCRA Facility Assessment (RFA). The RFA is currently in draft form, and is being reviewed by both EPA and MDEQE.

This completes the Hazardous Waste Ground-Water Task Force Evaluation of the Wyman-Gordon Company facility.

EXECUTIVE SUMMARY

INTRODUCTION

Concerns have been raised about whether hazardous waste treatment, storage, and disposal (TSD) facilities are complying with the ground-water monitoring requirements promulgated under the Resource Conservation and Recovery Act (RCRA)*. In question is the ability of existing or proposed ground-water monitoring systems to detect contaminant releases from waste management units. To evaluate these systems and determine the current compliance status of the TSD facilities, the Administrator of EPA established a Hazardous Waste Ground-Water Task Force ("Task Force"). The Task Force is composed of personnel from the EPA Office of Solid Waste and Emergency Response (OSWER), National Enforcement Investigation Center (NEIC), EPA regional offices, and state regulatory agencies. The Task Force is conducting in-depth investigations of TSD facilities with the following objectives for on-site facilities:

- Determine compliance with interim status ground-water monitoring requirements of 40 CFR Part 265 as promulgated under RCRA or the state equivalent (where the state has received RCRA authorization).
- Evaluate the ground-water monitoring program described in the facility's RCRA Part B permit application for compliance with 40 CFR Part 270.14(c) and potential compliance with Part 264.

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*Regulations promulgated under RCRA address hazardous waste management facility operations, including ground-water monitoring, to ensure that hazardous waste constituents are not released to the environment.

- Determine if the ground water underlying the facility contains hazardous constituents.

The Task Force has scheduled compliance inspections of ground-water monitoring systems at 58 TSD facilities. The Wyman-Gordon Company facility, located in North Grafton, Massachusetts, was inspected by the Task Force in July 1986 and is the subject of this inspection report. The inspection was led and coordinated by EPA Region I.

Massachusetts has received final authorization from EPA to run the RCRA program. The Massachusetts Hazardous Waste Regulations, including the ground-water monitoring requirements, are found in Massachusetts General Laws, Chapter 21C and 310CMR 30.000 and are essentially the same as those found in 40 CFR Parts 260 through 265, and Part 270. For simplicity, this report will reference Federal regulations.

Specific tasks of this investigation were to:

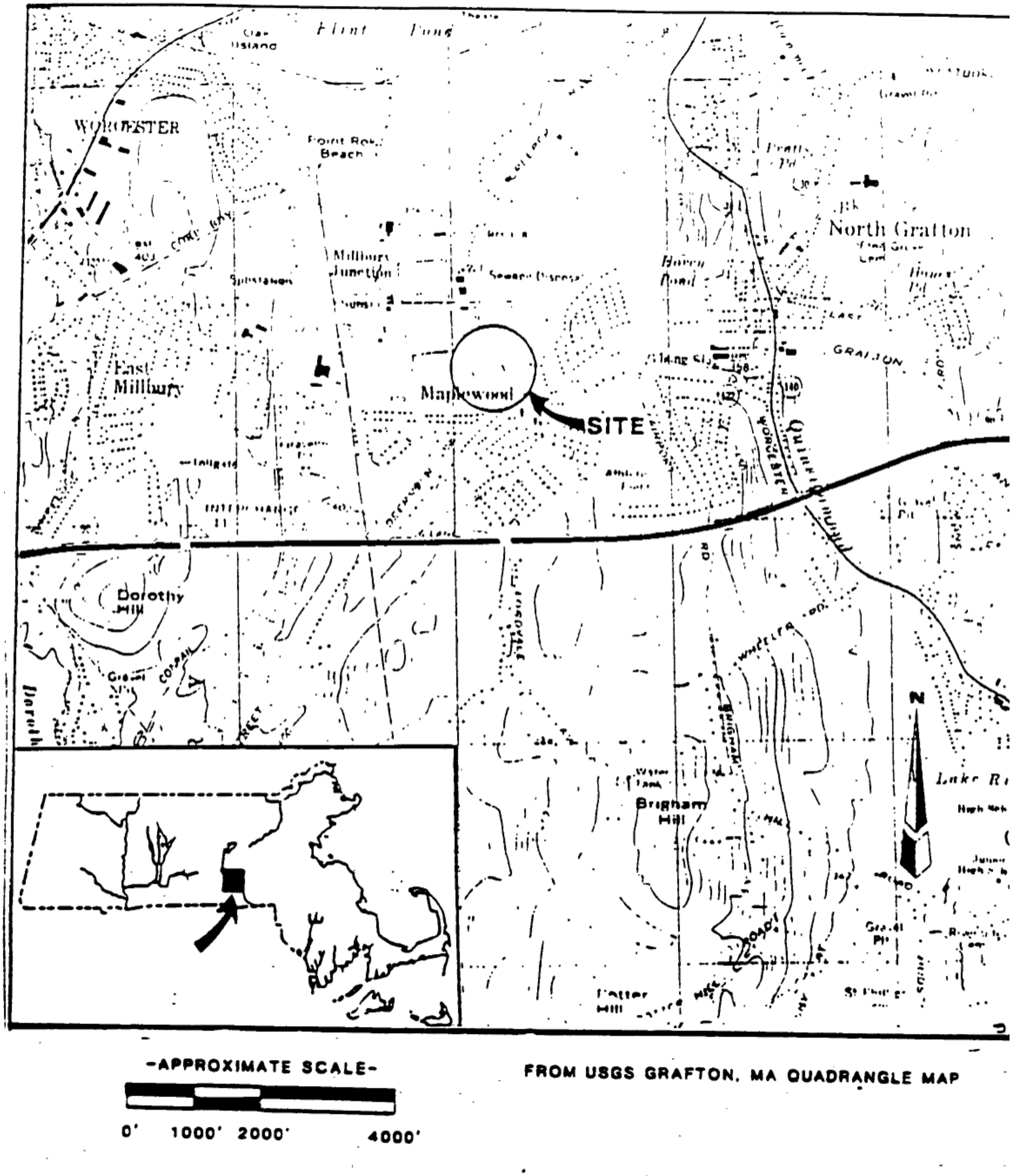
1. Evaluate the Wyman-Gordon ground-water sampling and analysis plan.
2. Evaluate sample collection, handling, and analytical procedures for the RCRA wells.
3. Evaluate the RCRA monitoring wells for proper construction and placement with respect to both interim status and permit requirements.
4. Determine whether the ground-water quality assessment plan is adequate.

To accomplish these tasks, the Task Force reviewed records, conducted a facility inspection, and collected samples from selected RCRA ground-water monitoring wells and the waste management units.

The Wyman-Gordon facility was constructed in 1973 and is located in North Grafton, Massachusetts (Figure 1). The North

FIGURE 1

SITE LOCATION



FROM USGS GRAFTON, MA QUADRANGLE MAP

Grafton area is underlain by unconsolidated glacial sediments, including till, outwash deposits, and ice-contact deposits. Areas of peat and fill are also common. The unconsolidated sediments are underlain by bedrock, identified as the Nashoba Formation. This formation is comprised of schist and gneiss. Ground water is the primary source of drinking water in the area. Public water supply wells are completed within the glacial deposits, while private wells are thought to be completed in bedrock (Wyman-Gordon, 1985). The Wyman-Gordon facility is bordered on the east by East Brook, which discharges to Hovey Pond.

The Wyman-Gordon facility manufactures ferrous and non-ferrous metal forgings for use in the aerospace and aircraft industries. The manufacturing processes involve chemical milling and etching through which metals are removed from the surface of forgings in order to eliminate scales from the surface and expose surface defects. The chemical milling and etching processes involve the use of strong acid and alkaline solutions depending on the metal involved. The metals removed during the chemical milling and etching processes consist of three groups: steel, titanium, and aluminum.

Wyman-Gordon operates a rinsewater treatment facility (RTF). There are 2 lagoons associated with the RTF which are classified as RCRA-regulated surface impoundments. The RTF treats the rinsewaters generated from the chemical milling and etching processes by feeding the rinsewaters through a series of pH adjustment tanks. There are a total of 42 other solid waste management units (SWMUs) at the site. These other SWMUs were visually inspected by the Task Force.

In 1973, Wyman-Gordon constructed two unlined surface impoundments (the "North" and "South" RTF lagoons) designed to allow the percolation of wastewaters from the RTF into the ground. The North RTF lagoon is connected to the South RTF lagoon by clay pipes that act as a conduit to channel off overflow when water levels in the South RTF lagoon exceed an elevation of 373 feet (ground surface). Between 1975 and August 1986, Wyman-Gordon discharged wastewaters from the RTF to the two RTF lagoons at the facility.

A byproduct of the wastewater treatment process is a sludge that forms in the RTF lagoons and is retained in the lagoons as the treated wastewater percolates through the lagoon bottoms. This sludge is classified as a wastewater treatment sludge from electroplating operations (F006, as found in 40 CFR Part 261.31). The F006 sludge is held primarily in the South RTF lagoon, which has a capacity of about 960,000 to 1,200,000 gallons of water and now holds approximately 827,000 gallons of accumulated sludge.

The facility has operated the North and South RTF lagoons under the interim status requirements for the storage of hazardous wastes since the federal regulations became effective in November 1980. A Part B permit application for the RTF lagoons was submitted to both EPA and the Massachusetts Department of Environmental Quality Engineering (MDEQE) on November 8, 1985. The application indicated that Wyman-Gordon intends to close the RTF lagoons some time prior to November 1988, as required by the Hazardous and Solid Waste Amendments (HSWA) of 1984.

Wyman-Gordon initiated a ground-water monitoring program for the RTF lagoons in 1982 with the installation of four monitoring wells (initially planned as one upgradient and three downgradient). The wells were constructed of PVC casing and screened the entire thickness of the saturated zone (approximately 15 to 25 feet). Ground-water flow was thought to be to the northeast, discharging to East Brook. Initial measurements and sampling were conducted in July 1982 and, as a result, Wyman-Gordon concluded that the RTF lagoons were impacting the ground water by:

(1) Causing local mounding in the ground-water flow (therefore no upgradient well unaffected by the facility existed)

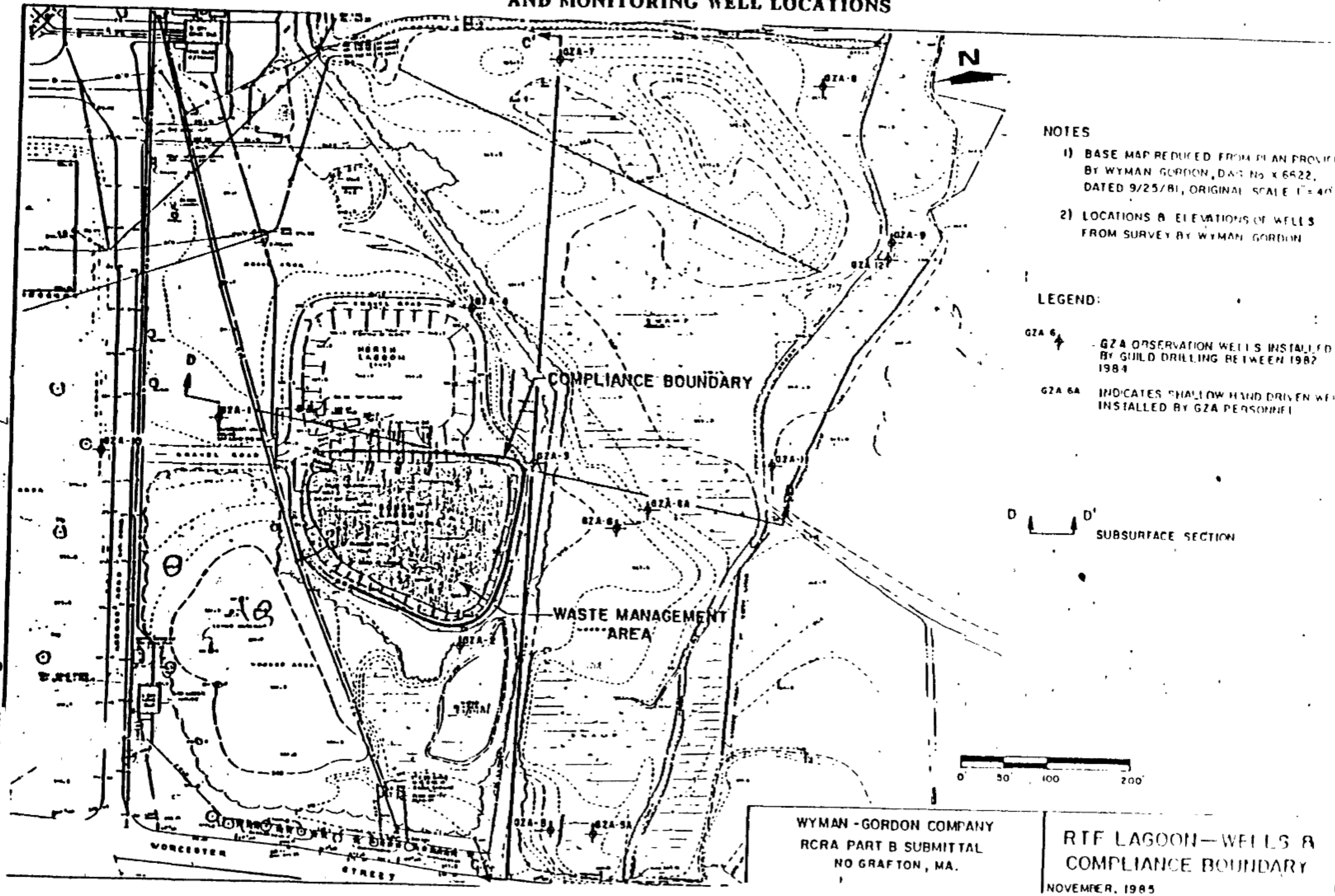
(2) Releasing hazardous wastes to the ground water, as evidenced by the presence of elevated levels of arsenic in one downgradient well (GZA-3) and elevated levels of nitrate in all four wells.

Based on these conclusions, Wyman-Gordon initiated an assessment program to determine the rate and extent of ground-water contaminant migration in August 1982. No initial background ground-water quality was established, however, nor was a statistical analysis conducted. At the time of the Task Force inspection, 10 additional wells had been installed, including one upgradient well outside the influence of mounding. Sample analyses of the additional wells confirmed the presence of arsenic and nitrate, and also indicated the presence of chromium, lead, nickel, and 1,1,1-trichloroethane in downgradient wells. Figure 2 shows locations of all the wells.

SUMMARY OF FINDINGS AND CONCLUSIONS

Task Force personnel inspected the interim status ground-water monitoring program at the Wyman-Gordon Company facility in North Grafton, Massachusetts, during the period from July 22 through July 24, 1986, to evaluate whether it met the RCRA requirements. The company initiated an interim status ground-water monitoring program in June 1982, although applicable provisions of the RCRA regulations became effective on November 19, 1981. The State of Massachusetts is authorized to administer and enforce the RCRA program outlined in 40 CFR Part 260 through Part 270. The findings and conclusions presented below reflect conditions existing at the facility from June 1982 to July 1986.

FIGURE 2
SURFACE IMPOUNDMENT
AND MONITORING WELL LOCATIONS



The Task Force has determined that Wyman-Gordon's interim status ground-water monitoring program does not fulfill the following requirements:

- 40 CFR Part 265.90(a) -- Wyman-Gordon did not have a ground-water monitoring program until July 1982, approximately 8 months after the ground-water monitoring requirements became effective (November 19, 1981).

- 40 CFR Part 265.91(a)(1) and (2) -- Wyman-Gordon initially assumed that ground-water flow direction was to the northeast. At the time of well installation (July 1982), Wyman-Gordon designated three of the four wells as downgradient wells (GZA-2, -3, -4), and the remaining well (GZA-1) as upgradient. Water level measurements taken in July 1982 indicated mounding in the ground-water surface as a consequence of the RTF lagoons. This resulted in all four wells being downgradient. No upgradient well existed until the installation of GZA-10 well in 1984.

- 40 CFR Part 265.91(c) -- Monitoring wells are not adequately sealed to prevent contamination from entering the screened interval from above, thus affecting the integrity of ground-water samples. At the time of the Task Force inspection, several wells were not sealed at the surface (see Table 1). In addition, the bentonite seals are approximately 1 foot thick (see Table 4). Industry standards generally call for at least 2-foot-thick seals. In addition, at the time of the Task Force inspection, wells GZA-2, GZA-3, GZA-4, GZA-6, GZA-6A, and GZA-10 did not have concrete collars and/or PVC caps (see Table 1), adding to the possibility that contamination may infiltrate the well from the surface.

- 40 CFR Part 265.92(a) -- Wyman-Gordon's Sampling and Analysis Plan (SAP) contains no schedules for background sampling, nor has the SAP been updated to include Phase II and Phase III wells, or procedures that may have changed since 1982.

- 40 CFR Part 265.93(d)(4): Because the monitoring wells are inadequately constructed, Wyman-Gordon has failed to adequately determine the rate and extent of migration, and the concentrations of hazardous wastes or hazardous waste constituents in the ground water as a result of RTF lagoon influence.

- 40 CFR Part 265.93(d)(7)(i) -- Wyman-Gordon has not established concentrations for hazardous waste constituents as required by assessment monitoring.

In addition, the following deficiencies exist:

- Screen lengths in all wells are the entire length of the saturated zone. This does not allow for sampling discrete portions of the highly variable unconsolidated sediments.
- Ground-water surface elevations and well casing heights were measured only to the nearest 0.1 foot. Elevations should be taken to the nearest 0.01 foot to ensure accurate flow evaluations and to provide a check on the integrity of the well (e.g., identify siltation problems). The Task Force did note that well depths have become shallower, which may indicate that siltation has occurred (see Table 5).
- Wyman-Gordon has failed to adequately define bedrock characteristics through borings, and they have failed to determine whether bedrock is part of the uppermost aquifer.
- Vertical ground-water flow gradients for the bedrock and unconsolidated surficial deposits have not been determined.
- Wyman-Gordon's ground-water flow calculations appear to be based on average permeability of the unconsolidated sediments portion of the aquifer; however, flow may be occurring in discrete lithologic units of these sediments.

The Task Force has determined that Wyman-Gordon's ground-water assessment program is not adequate to assess the rate, extent, and concentration of hazardous waste constituents in ground water as required by 40 CFR 265.93(d). The Task Force specifically determined that the installation of additional wells is required to better characterize the hydrogeology of the facility area. Specifically, the vertical components of flow in both the unconsolidated surficial sediments and bedrock portions of the aquifer need to be defined. In addition, Wyman-Gordon's ground-water flow calculations appear to be based on an average permeability of the unconsolidated sediments portion of the aquifer; however, flow may be occurring in discrete lithologic units of these unconsolidated sediments. Wyman-Gordon must, therefore, more adequately define permeabilities for zones within the sediment portion of the aquifer. Furthermore, Wyman-Gordon must define whether the bedrock portion of the aquifer is hydraulically connected with the overlying sediments.

In addition, the Task Force recommends that deficiencies in the facility's ground-water monitoring program be addressed as follows:

- Implement a quarterly monitoring program that includes sampling a number of surface and ground-water points at the boundaries of and within the contaminant plume and at any environmental receptors, sufficient to define the migration rate of the contaminant plume.

- Implement a sampling program that includes sampling for a number of parameters sufficient to define the composition of the contaminant plume.

- Measure ground-water elevations in all wells and the surface elevation of East Brook on a quarterly basis.

- Determine the geologic character of the bedrock underlying the facility and whether the bedrock is part of the uppermost aquifer.

- Determine the direction and magnitude of vertical ground-water flow gradients in the bedrock and surficial unconsolidated deposits between the RTF lagoons and East Brook.

- Assess the extent and vertical distribution of contamination east of the RTF lagoons.

During the review of the Part B permit application, the Task Force found that the ground-water monitoring system is deficient. Specifically,

- 40 CFR Part 270.14(c)(2) -- The facility has not adequately characterized the site hydrogeology and uppermost aquifer.

- 40 CFR Part 270.14(c)(4)-- The facility has not adequately defined the extent of ground-water contamination from the RTF lagoons.

- 40 CFR Part 270.14(c)(4)(ii) -- The facility has not sampled ground-water for all Appendix VIII hazardous constituents.

- 40 CFR Part 270.14(c)(7) -- The facility has not submitted sufficient data to establish a compliance monitoring program or an engineering feasibility plan for a corrective action program.

- 40 CFR Part 264.95 -- The waste management area does not include the North RTF lagoon.

- 40 CFR Part 264.97(c) -- Existing monitoring wells are not properly constructed to ensure the integrity of ground-water samples (i.e., lack of concrete seals, excessive screen lengths).

- 40 CFR Part 264.94(b)(1) -- The alternate concentration limits demonstration is inadequate since the site is not properly characterized in terms of its hydrogeochemistry.

TECHNICAL REPORT

INVESTIGATIVE METHODS

The Task Force evaluation of the Wyman-Gordon Company facility consisted of:

- Reviewing and evaluating records and documents from EPA Region I, the Massachusetts Department of Environmental Quality Engineering (MDEQE), and the Wyman-Gordon Company
- Inspecting the facility during the period from July 22 through July 24, 1986
- Sampling selected ground-water points and lagoon liquids, analyzing the samples and evaluating the data.

Records/Documents Review and Evaluation

Records and documents from EPA Region I and MDEQE offices were reviewed prior to the on-site inspection to evaluate facility operations, identify location and construction details of waste management units, and evaluate ground-water monitoring activities. On-site facility records were reviewed to verify the information in Government files and to supplement the information, where necessary. Selected documents requiring in-depth evaluation were copied by the Task Force during the inspection.

Specific documents and records reviewed and evaluated included the ground-water sampling and analysis plan (SAP), analytical results from past ground-water sampling, monitoring well construction data and logs, site geologic reports, site operations plans, facility permits, waste management unit design and operation reports, selected personnel position descriptions and qualifications (those related to the required ground-water monitoring program), and operating records showing the general types and quantities of wastes disposed of at the facility.

Facility Inspection

The facility inspection included identifying waste management units; identifying and assessing waste management operations, pollution control practices, surface drainage routes, and local land uses; and verifying the location of the ground-water monitoring system.

Wyman-Gordon Company representatives were interviewed to identify records and documents of interest, discuss the contents of the documents and explain facility operations and design (past and present), the site hydrogeology, the rationale for the ground-water monitoring system, and the SAP.

Waste Management Units

Two RTF lagoons exist at the Wyman-Gordon facility, the North lagoon and the South lagoon (see Figure 3). The lagoons were constructed in 1973 as percolation lagoons in a fill area in the southeast corner of the facility (known as the "East Side"), adjacent to a wetland and a stream known as East Brook. The South lagoon has a surface area of approximately 32,000 square feet and an average depth of 4 to 5 feet; it is capable of holding 960,000 to 1,200,000 gallons of liquid. The North Lagoon is connected to the South lagoon via three clay pipes. The North lagoon receives overflow from the South lagoon when the water level in the South lagoon exceeds an elevation of +373 feet. A berm surrounds the two lagoons (Wyman-Gordon, 1985).

Wyman-Gordon uses chemical milling and etching processes at its North Grafton facility. Rinsewater from these processes is treated in an on-site wastewater treatment unit and is then discharged to the South lagoon. These treated wastewaters are classified as F006 wastes (40 CFR 261.31, wastewater treatment sludges from electroplating operations). The metal concentrations and pH of lagoon water samples taken in November 1983 and June 1985 are given in Appendix A.

Wyman-Gordon has estimated the sludge volume in the South lagoon at 827,000 gallons. As part of a delisting petition, Wyman-Gordon sampled the sludge accumulated after construction of the South lagoon and the sludge generated from wastewaters entering the South lagoon in 1983 (known as "old" sludge and "new" sludge, respectively). Both the "old" and "new" sludges were analyzed for total- and EP toxicity metal concentrations. Analytical results for the sludges are listed in Appendix A. Cadmium, chromium, and nickel, as well as arsenic, and other metals were found in the sludge samples.

Other Solid Waste Management Units

Wyman-Gordon provided information on 42 other solid waste management units (SWMU) in addition to the lagoons (EPA, 1985). These other SWMUs include a hazardous waste storage area for tanks and containers and several pre-RCRA SWMUs. The SWMUs that appear to be of most potential significance during the inspection were:

- Three areas where oily wastes were placed directly onto the ground (East Side)
- Two underground waste oil tanks (East Side)
- A landfill area used for disposal of polishing and plating wastes, acids, bases, and heavy metal wastes (East and West Side)

- A disposal area, located in the southeast portion of the site, used for spreading 11 cubic yards of magnesium chips and 16 cubic yards of aluminum sulfate powder (East Side)

Ground-water data from samples obtained from monitoring wells located in the East Side study area show organic contamination.

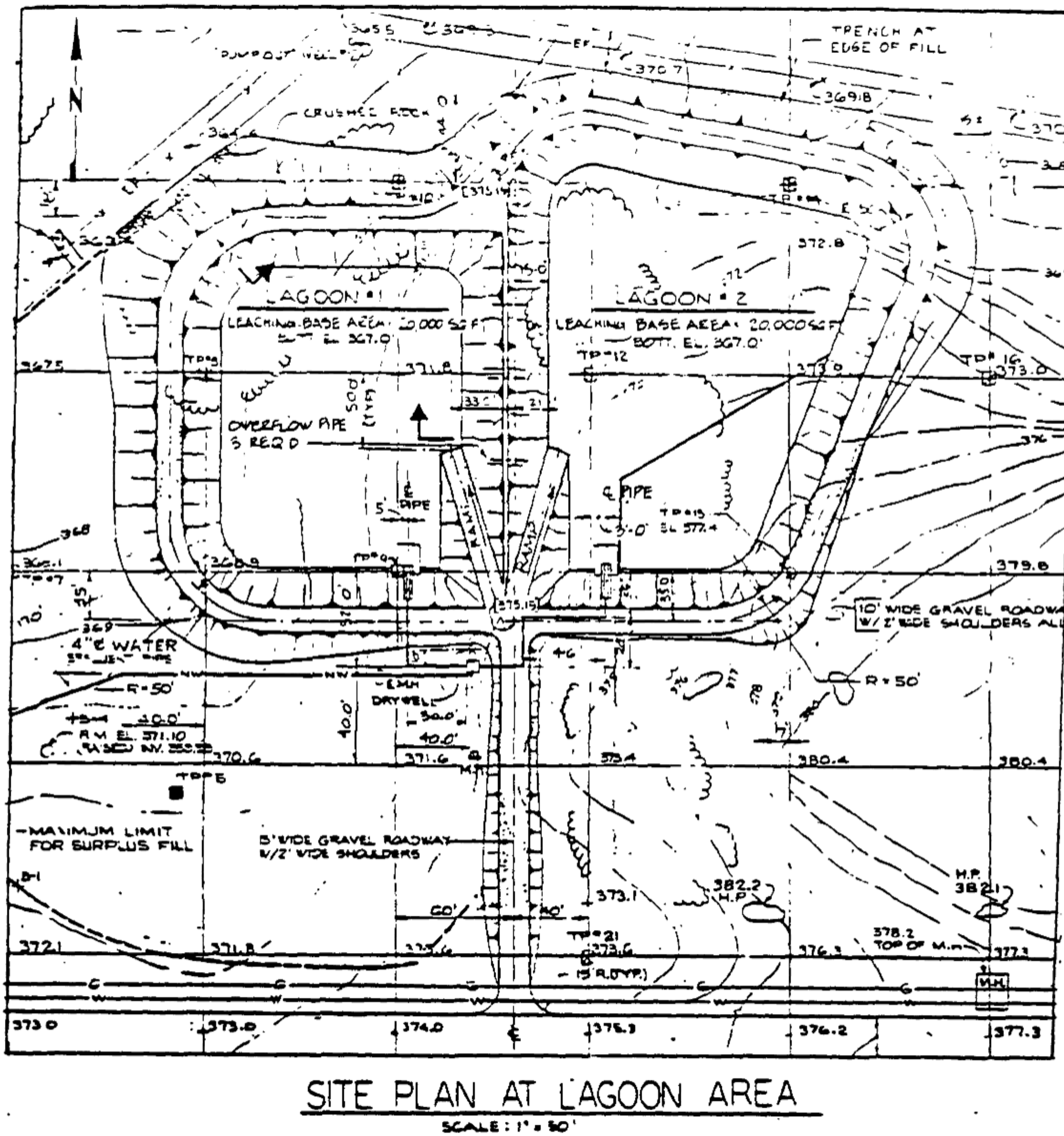
Task Force Sample Collection and Handling Procedures

During the inspection, samples were collected by an EPA contractor to determine if the ground water at Wyman-Gordon contains hazardous waste constituents or other indicators of contamination. Water samples were collected from wells GZA-2, 3, 4, 6, 6A, 10, 11, and 12, and a surface water sample was collected from the South lagoon (see Tables 1 and 2). Duplicate samples were taken at wells GZA-11 and GZA-6, trip blanks were prepared prior to the visit, and field and equipment blanks were poured at the site during sampling.

Water level measurements were taken using an electric meter at RCRA wells during the first day of the on-site investigation prior to any well sampling. Water levels were measured at all wells even if they were not sampled. During the sampling of a well, the wellhead and breathing zone of personnel collecting the samples were monitored for chemical vapors with a photoionization/organic vapor detector. An interface probe was used to measure depth to water and to determine if multiple phases were present in the wells. No separate liquid phases were detected.

FIGURE 3

SITE PLAN AT LAGOON AREA



Source: Wyman-Gordon, 1985

TABLE 1

HAZARDOUS WASTE GROUND-WATER TASK FORCE
WELL MEASUREMENTS

Well	Depth to Water (ft)	Total Depth (ft)	Water Table Elevation[3] (ft)	Construction Comments from Field Notes	pH	Temperature °C	Specific Conductivity umho/cm	Turbidity NTU
GZA-1	11.38	38.08	364.27	NA[2]	NA	NA	NA	NA
GZA-2	9.60	22.18	366.70	Well was bent; no concrete collar; no PVC cap	7.0	13.8	1650	[illegible]
GZA-3	10.36	22.41	361.94	No concrete collar; no PVC cap	8.1	21.4	1940	[illegible]
GZA-4	3.28	20.17	360.62	Well head below ground, contamination likely; material present inside road box; no concrete collar	6.9	14.1	1550	0.25
GZA-5	5.01	24.02	366.09	NA	NA	NA	NA	NA
GZA-5A	3.55	6.11	365.90	NA	NA	NA	NA	NA
GZA-6	8.74	33.46	360.36	No PVC cap; concrete collar broken up	9.7	13.3	1850	0.5
GZA-6A	2.68	8.18	365.62	No concrete collar	10.8	13.4	2100	3.5
GZA-7	5.64	35.14	357.66	NA	NA	NA	NA	NA
GZA-8	2.75	40.86	356.05	NA	NA	NA	NA	NA
GZA-9	3.87	8.10	357.18	NA	NA	NA	NA	NA
GZA-10	10.16	33.47	(4)	Well head below ground; inner casing no cap, no concrete collar	6.0	11.2	250	2.7
GZA-11	2.50	26.68	(4)	No comments	7.6	16.6	1750	9.0
GZA-12	3.54	17.35	(4)	No comments	6.0	12.3	250	5.1

Notes:

Source: Task Force field notebooks.

1 NTU = Nephelometric turbidity units.

2 NA: not available; well not sampled.

3 Water table elevations calculated using top of casing elevations in Appendix B

4 No top of casing elevation available

TABLE 2

HAZARDOUS WASTE GROUND-WATER TASK FORCE
SAMPLE COLLECTION DATA

Traffic No.	Sample Point	Date	Time	Parameter Sampled For
MQA618	Field Blank			Inorganics[1], Metals[2]
Q1318	Field Blank			Organics[3]
MQA621	Trip Blank			Inorganics, Metals
Q1321	Trip Blank			Organics
MQA495	Equipment Blank			Inorganics, Metals
Q1295	Equipment Blank			Organics
MQA492	GZA-11	07/23/86	12:35 pm	Inorganics, Metals
Q1292	GZA-11			Organics
MQA616	GZA-11	07/23/86	12:35 pm	Inorganics, Metals
Q1316	GZA-11			Organics
MQA615	GZA-6A	07/23/86	2:00 pm	Inorganics, Metals
Q1315	GZA-6A			Organics
MQA497	GZA-6	07/23/86	12:11 pm	Inorganics, Metals
Q1297	GZA-6			Organics
MQA499	GZA-6	07/23/86	12:01 pm	Inorganics, Metals
Q1299	GZA-6			Organics
MQA494	GZA-12	07/23/86	10:06 am	Inorganics, Metals
Q1294	GZA-12			Organics
MQA496	Lagoon	07/22/86	1:35 pm	Inorganics, Metals
Q1296	Lagoon			Organics
MQA500	GZA-10	07/22/86	10:00 am	Inorganics, Metals
Q1300	GZA-10			Organics
MQA614	GZA-4	07/22/86	11:22 am	Inorganics, Metals
Q1314	GZA-4			Organics
MQA619	GZA-3	07/22/86	1:48 pm	Inorganics, Metals
Q1319				Organics
MQA620	GZA-2	07/23/86	10:05 am	Inorganics, Metals
Q1320	GZA-2			Organics

Notes:

Source: Task Force Field Notebooks.

1 Inorganics include the inorganic indicator parameters.

2 Metals include total metals and dissolved metals.

3 Organics include volatile and semi-volatile organics, pesticides, and PCBs.

Prior to sampling, each well was purged of at least three water column volumes with a peristaltic pump. Purge water was collected in buckets and discharged to the facility's wastewater treatment tanks or surface impoundment. Purge water was monitored for pH, temperature, and specific conductance during purging.

Wells were sampled using pre-cleaned stainless steel bailers dedicated for each well. Field measurements were made on the first sample aliquot for temperature, pH, and specific conductivity. The remainder of the sample volumes were collected in accordance with guidelines in Table 3. Following sampling, turbidity was measured; samples for metals, total organic carbon (TOC), phenols, cyanide, nitrate, and ammonia were preserved as indicated in Table 3. All equipment that was to be reused was thoroughly cleaned by the sampling contractor as detailed in Appendix D.

Wyman-Gordon requested split samples for all parameters. To assure comparability between sets of samples, the containers for each set of parameters (except volatile organics) were filled one-third each in sequence, followed by filling each with the second third, and finally by the last third. The same procedures were followed with the sample splits requested by MDEQE, except that the containers were filled in fourths.

The EPA sampling contractor provided all equipment and materials necessary to collect, manage, handle, document, and ship the required samples, including enough sample containers for all split and replicate samples, preservatives for environmental samples, sealable shipping containers, custody seals and shipping labels, chain-of-custody forms, sample tags, sample receipt forms for all samples, decontamination equipment and supplies, personalsafety gear, and ancillary materials. The sample contacting surfaces of all sample collection equipment were fabricated of inert materials such as Teflon or glass.

All samples were shipped to the EPA contractor laboratory in accordance with the applicable Department of Transportation (DOT) regulations (49 CFR Parts 171-177) and NEIC Standard Operating Procedures. Wyman-Gordon was responsible for shipping samples to its laboratory, including costs.

GEOLOGY AND HYDROGEOLOGY

Wyman-Gordon has employed a consultant since 1982 to design the ground-water monitoring system, determine the site geology and hydrogeology, and conduct the hydrogeologic studies. The consultant and the monitoring wells/borings installed by the consultant are referenced by the letters "GZA." Information available to the Task Force on site geology and hydrogeology is found in "Wyman-Gordon" (1985), and "Goldberg-Zoino and Associates, Inc." (1983, 1984).

Stratigraphy

The bedrock beneath the site has been mapped as the Nashoba Formation. The Nashoba Formation is composed of schist and gneiss. Judging by an outcrop near the impoundments, some bedrock fractures should be present in the subsurface, which is typical of New England geology. During monitoring well installation, the depth to apparent bedrock (i.e., refusal of the rotary bit) varied from 22 to 41.5 feet. Bedrock was not cored.

The surficial geology of the area surrounding the Wyman-Gordon site is primarily the result of the last glaciation of the New England region. Several types of sediments were deposited during the advance and retreat of the ice sheet.

TABLE 3

PREFERRED SAMPLE BOTTLE TYPE AND PRESERVATIVE LIST

	Parameter	Bottle	Preservative
1.	Volatile Organic Analysis (VOA) Purge and Trap	2 40-ml VOA vials	Cool 4° C
2.	Purgeable Organic Carbon (POC)	1 40-ml VOA vials	Cool 4° C
3.	Purgeable Organic Halogens (POX)	1 40-ml VOA vials	Cool 4° C
4.	Extractable Organics	4 1-qt amber glass	Cool 4° C
5.	Pesticide/Herbicide		Cool 4° C
6.	Total Metals	1 1-qt plastic	HNO_3 - 5ml
7.	Dissolved Metals	1 1-qt plastic	HNO_3 - 5ml
8.	Total Organic Carbon (TOC)	1 4-oz glass	H_2SO_4 - 5 ml
9.	Total Organic Halogens (TOX)	1 1-qt amber glass	Cool 4° C, No headspace
10.	Phenols	1 1-qt amber glass	H_2SO_4 - 5 ml, Cool 4° C
11.	Cyanide	1 1-qt plastic	NaOH - 5 ml, Cool 4° C
12.	Sulfate/Chloride	1 1-qt plastic	Cool 4° C
13.	Nitrate/Ammonia	1 1-qt plastic	H_2SO_4 - 5 ml, Cool 4° C

Source: Hazardous Waste Ground-Water Task Force Project Plan, Wyman-Gordon

As the ice advanced, glacial till was deposited over bedrock in most of the area. As the ice retreated, a variety of meltwater-laid sediments were deposited over the till in valleys and other low-lying areas. In low-lying, poorly drained areas, swamp deposits have accumulated over glacial deposits since the retreat of the ice sheet. In recent years, fill has apparently been placed in some areas. Profiles of typical conditions from GZA boring data are depicted in Figure 4.

Glacial till was observed at each of GZA's borings, but was not observed at the surface in the vicinity of the lagoons. The till consists of varying proportions of fine to coarse sand, fine to coarse gravel, silt, cobbles, and boulders. In general, the till encountered at Wyman-Gordon is less silty than is commonly observed in the region. The thickness of till observed in GZA's borings ranged from less than 1 foot at boring GZA-7 to over 16 feet at borings GZA-1, GZA-4, and GZA-10. As shown in subsurface profiles (Figure 4), the till appears to form a small buried mound or hill underlying the Phase I RCRA wells; it decreases in thickness toward GZA-5, GZA-6 and GZA-7.

Ice-contact materials (sediments deposited near the ice front during the retreat of the ice sheet) were observed overlying glacial till in all GZA borings except GZA-3 and GZA-4. These sediments consist predominantly of sand, with lesser amounts of gravel and silt. In general, the ice-contact materials are less dense and contain less silt that the underlying glacial till, although exceptions were noted by GZA (1983). The gradual transition between till and ice-contact deposits in the study area suggests a complex depositional history in the immediate vicinity of the ice front.

A dense granular fill material was encountered in many borings in the vicinity of the lagoons. The fill consists of sand and gravel, with lesser amounts of silt, cobbles, and boulders. The fill is apparently reworked and compacted glacial till and possibly some ice-contact material from the area. The distinction between fill and glacial till was based primarily on stratigraphic position.

Peat was encountered at the surface in borings GZA-8, GZA-11, and GZA-12 and at three hand-installed "wells" (GZA 5A, 6A, and 9). A 2-foot peat layer was found underlying the fill at GZA-2 and GZA-10. The peat is a dark brown, fibrous organic material containing some silt and sand. The maximum observed thickness of peat was 6 feet at GZA-8.

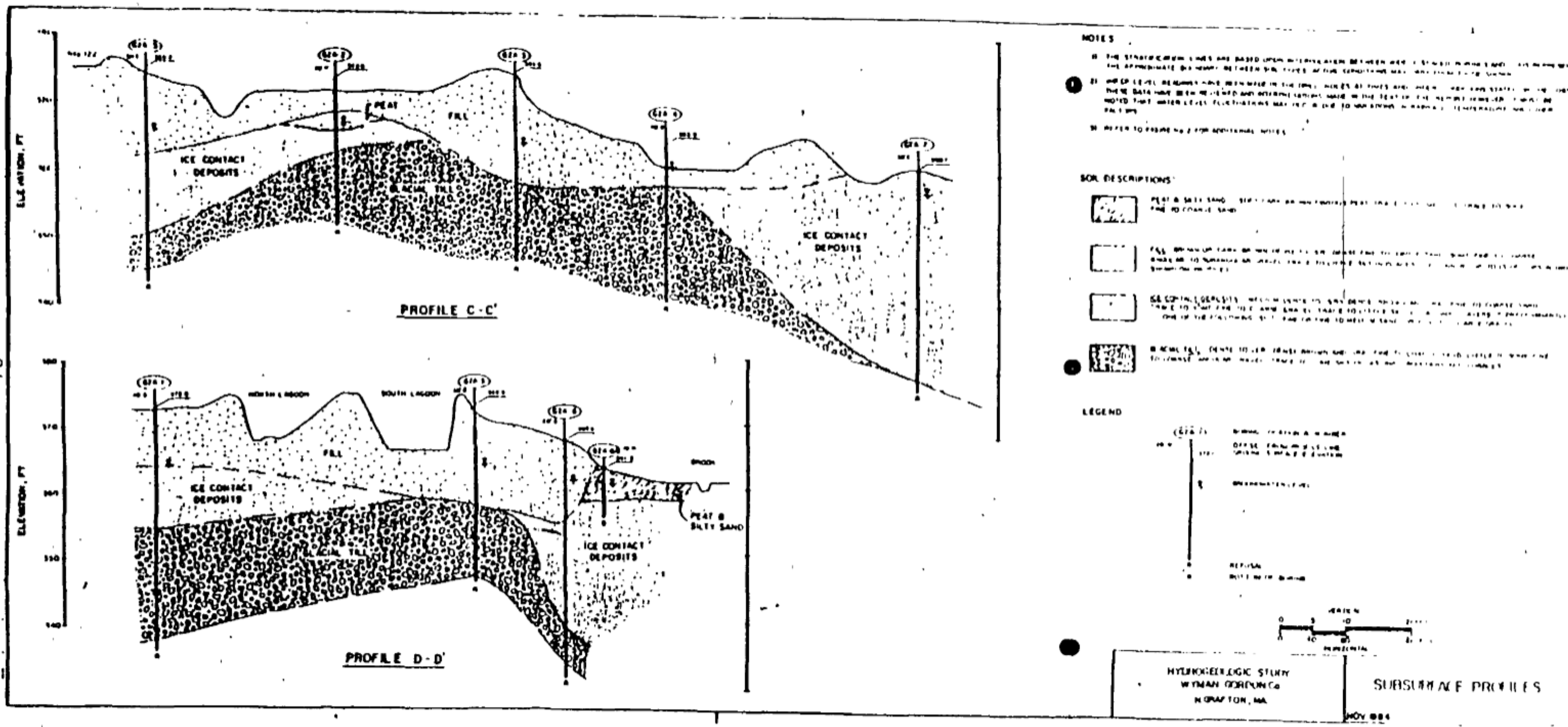
Surface Water Hydrology

Wyman-Gordon's North Grafton plant is located within the Blackstone River Basin. The area around the lagoons is drained by a brook, known as East Brook, which flows northward along the eastern boundary of the site. East Brook joins the Quinsigamond River at Hovey Pond, approximately 1/2 mile from the study area. The Quinsigamond River joins the Blackstone River approximately 4 miles to the south of the facility.

Ground-Water Hydrology

The ground-water elevations observed in September 1982 were used to develop the contours shown on Figure 5. As indicated on Figure 5, the apparent direction of ground-water flow across the study area is northeasterly. However, recharge from the South lagoon apparently resulted in ground-water mounding in the vicinity of the lagoons. Thus, ground water may flow radially from the lagoons, not only to the northeast, but toward the northwest and southeast; a westerly flow component from the lagoons could affect water

FIGURE 4
GEOLOGIC CROSS-SECTION



Source: Wyman-Gordon, 1984

however, and distorted flow paths eventually merge into the regional northeasterly flow pattern. East Brook may represent the eventual discharge point for ground water moving through the Wyman-Gordon facility area.

Wyman-Gordon suggests that ground-water flow is predominantly easterly toward the wetland and East Brook, based on ground-water elevation data from north of the immediate facility area (Wyman-Gordon, 1985). Figure 6 depicts ground-water contours constructed in the area east of the main plant based on data recorded in July and September 1984. These contours reflect the regional flow toward East Brook from the Wyman-Gordon property and the course of the brook prior to its discharge into Hovey Pond. It is important to note that these flow directions are indicative only of generalized regional flow. The elevation data were not obtained on the same day; however, it is not known whether this would have influenced the results.

During interim status, 11 soil borings were made in the region of the RTF lagoons. Three additional shallow borings were completed in hand excavated holes. A total of 14 monitoring wells were then installed in these boreholes. Locations and designations of all wells are shown in Figure 2. Appendix C presents the borings logs for the monitoring wells.

Borings within the study area were completed in three major phases:

- o Phase I -- Monitoring wells GZA-1 through GZA-4 were installed in an attempt to satisfy the RCRA requirements of one upgradient (GZA-1) and three downgradient (GZA-2, GZA-3, GZA-4) wells.
- o Phase II -- Wells GZA-5 through GZA-9 were installed to supplement the initial RCRA wells and address the issues concerning the extent of migration of RTF lagoon effluent constituents in ground water.
- o Phase III -- Wells GZA-10, GZA-11, and GZA-12 were completed to respond to issues on upgradient water quality and the eastern extent of the RTF lagoon influence.

GROUND-WATER MONITORING PROGRAM DURING INTERIM STATUS

Ground-water monitoring at the Wyman-Gordon facility has been conducted under the Massachusetts interim status regulations (Massachusetts General Laws Chapter 21C and 310 CMR 30.000). The following evaluates the facility's program between November 1981, when the ground-water monitoring provisions of the RCRA requirements became effective, and July 1986, when the Task Force investigation was conducted.

Regulatory Requirements

The State of Massachusetts has received final authorization to administer the RCRA hazardous waste program. At the time of final authorization, the state regulations became enforceable in lieu of the federal regulations. Ground-water monitoring at the site is now regulated by MDEQE regulations, which are equivalent to 40 CFR Part 264, 265, and 270.

Monitoring Well System

The ground-water monitoring system was initiated in June 1982 with the installation of four monitoring wells identified as GZA-1 through GZA-4 (also known as Phase I wells). As shown on Figure 2, these wells were installed in the immediate vicinity of the RTF lagoons. Wyman-Gordon assumed ground-water flow direction to be northeast toward East Brook. Well GZA-1 was designated the upgradient well, and wells GZA-2 through GZA-4 were designated downgradient wells.

Wells were constructed in borings first made by driving a 3- or 4-inch diameter casing to a sampling depth and washing out the soil using a hydraulically-powered rotary bit. Borings were terminated at the apparent top of the bedrock. Wells were completed by installing a 1.5-inch diameter PVC pipe within the hollow drive casing machine slotted 0.010-inch screened sections intercept the entire thickness of the saturated zone. Wells were reportedly sealed with a bentonite slurry, and concrete collars were installed at the surface (Wyman-Gordon, 1985). A summary of monitoring well construction is shown in Table 4; Appendix C contains boring logs and well completion diagrams for the monitoring wells.

Ground-water elevations were initially measured in GZA-1 through GZA-4 in July 1982. Based on the measurements, Wyman-Gordon determined that mounding was occurring as a consequence of the RTF lagoons. The upgradient well (GZA-1) was within the area of mounding and, therefore was, not an upgradient well as initially designated.

Initial ground-water samples were also collected in July 1982. Analysis showed elevated levels of arsenic in GZA-3 and elevated levels of nitrates in all four wells. Wyman-Gordon, therefore, decided that the RTF lagoons were directly impacting ground-water quality, and the company initiated a ground-water assessment program.

Massachusetts regulations (equivalent to 40 CFR Part 265.93) require facilities to prepare an outline of a ground-water quality assessment program. This outline must describe a more comprehensive program than the one for routine interim status monitoring and provide for determining the following:

- o Whether hazardous waste or hazardous waste constituents have entered the ground water
- o The rate and extent that hazardous waste or hazardous waste constituents migrate in the ground water
- o The concentrations of hazardous waste or hazardous waste constituents in the ground water

If analysis conducted under the interim status program indicates facility may be affecting ground water, additional samples are to be done immediately to determine if the original analytical results were bias error. If ground-water effects are still suspected, an assessment prior developed based on the outline and specifying:

- o Number, location, and depth of wells
- o Sampling and analytical methods for those hazardous wastes or hazardous waste constituents at the facility
- o Evaluation procedures, including any use of previously gathered ground-water quality information
- o A schedule of implementation

Upon Wyman-Gordon's July 1982 conclusion that the RTF lagoons were affecting ground water at the facility, Wyman-Gordon initiated a ground-water assessment program. Wyman-Gordon installed wells GZA-5 through GZA-9, including GZA-5A and GZA-6A, in August 1982. These seven wells are known as the Phase II wells. The Phase II wells did not include an upgradient well, and Wyman-Gordon, therefore, installed three additional wells (GZA-10,

FIGURE 5
INTERPRETATION OF GROUND-WATER CONTOURS
BASED ON 1982 DATA

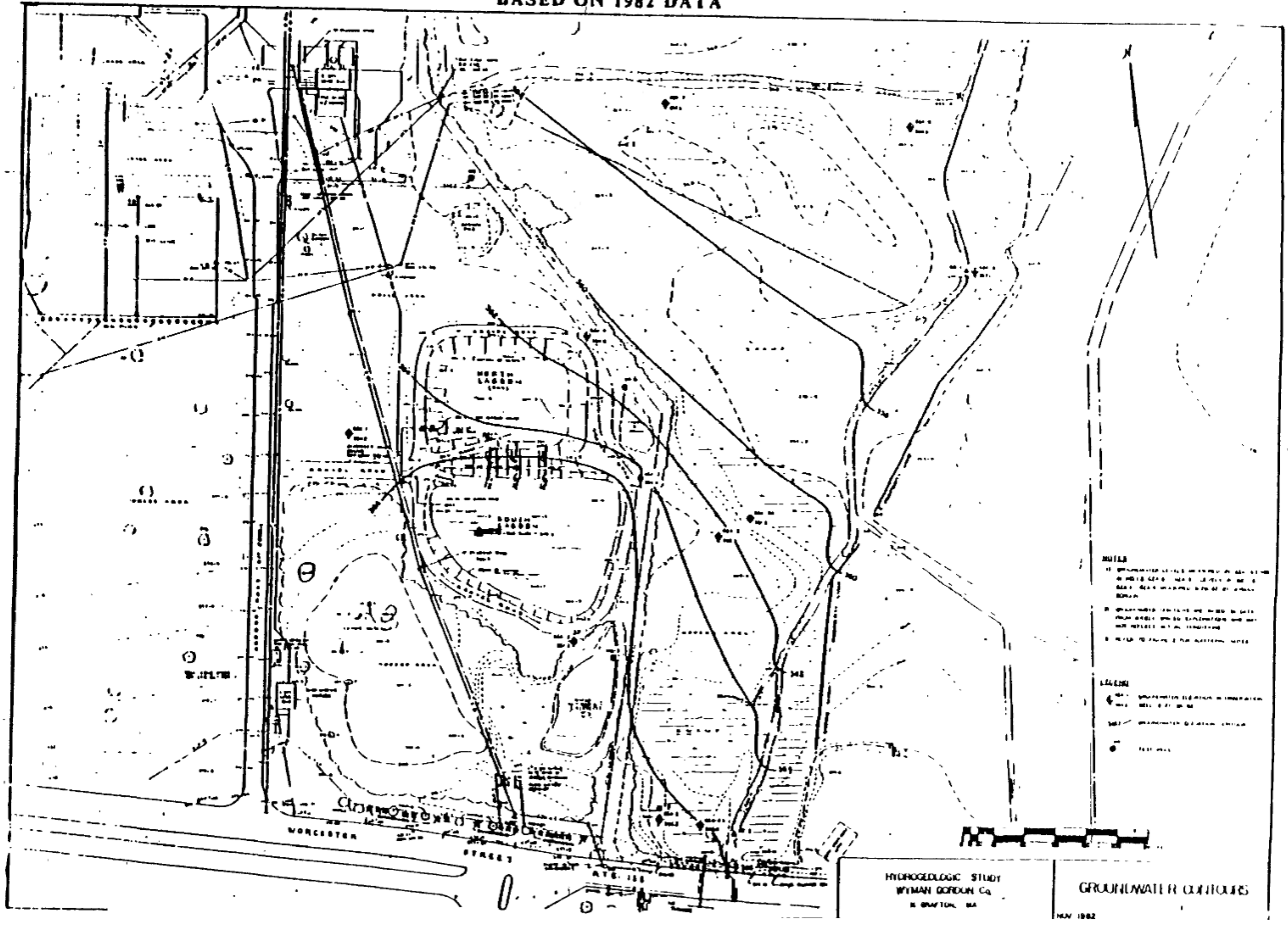
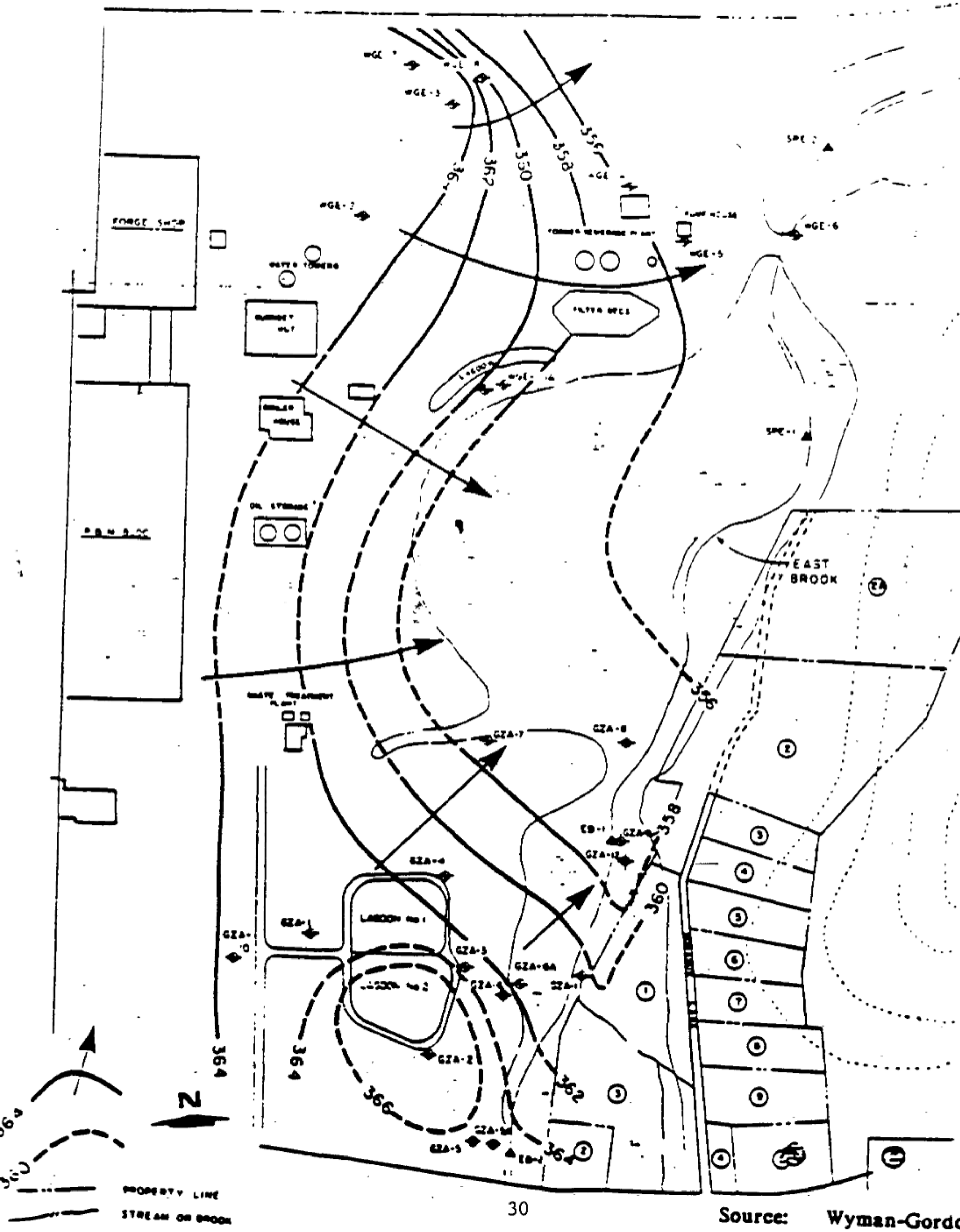


FIGURE 6
GROUND-WATER CONTOURS NORTH OF THE IMPOUNDMENTS



Source: Wyman-Gordon, 1985

GZA-11, and GZA-12, known as the Phase III wells) in June and August 1984 to define upgradient water quality (GZA-10), and the eastern extent of lagoon influent (GZA-11, 12).

All but three wells (GZA-5A, GZA-6A, and GZA-9) were constructed and screened identically to the Phase I wells. GZA-5A, GZA-6A, and GZA-9 were hand-driven in a wetland area and constructed of stainless steel (see Table 5 and Appendix C).

The Task Force determined that the following violations existed in Wyman-Gordon's ground-water monitoring program:

- 40 CFR Part 265.90(a) -- Wyman-Gordon did not have a ground-water monitoring program until July 1982, approximately 8 months after the ground-water monitoring requirements became effective (November 19, 1981).

- 40 CFR Part 265.91(a)(1) and (2) -- Wyman-Gordon initially assumed that ground-water flow direction was to the northeast. At the time of well installation (July 1982), Wyman-Gordon designated three of the four wells as downgradient wells (GZA-2, -3, -4), and the remaining well (GZA-1) as upgradient. Water level measurements taken in July 1982 indicated mounding in the ground-water surface as a consequence of the RTF lagoons. This resulted in all four wells being downgradient. No upgradient well existed until the installation of GZA-10 well in 1984.

- 40 CFR Part 265.91(c) -- Monitoring wells are not adequately sealed to prevent contamination from entering the screened interval from above, thus affecting the integrity of ground-water samples. At the time of the Task Force inspection, several wells were not sealed at the surface (see Table 1). In addition, the bentonite seals are approximately 1 foot thick (see Table 4). At least two foot thick seals are preferable. In addition, at the time of the Task Force inspection, Wells G, GZA-3, GZA-4, GZA-6, GZA-6A, and GZA-10 did not have concrete collars and/or PVC caps (see Table 1), adding to the possibility that contamination may infiltrate the well from the surface.

- 40 CFR Part 265.93(d)(4): Because the monitoring wells are inadequately constructed, Wyman-Gordon has failed to adequately determine the rate and extent of migration, and the concentrations of hazardous wastes or hazardous waste constituents in the ground water as a result of RTF lagoon influence.

- 40 CFR Part 265.93(d)(7)(i) -- Wyman-Gordon has not established concentrations for hazardous waste constituents as required by assessment monitoring.

In addition, the following deficiencies exist:

- Screen lengths in all wells are the entire length of the saturated zone. This does not allow for sampling discrete portions of the highly variable unconsolidated sediments.

- Ground-water surface elevations and well casing heights were measured only to the nearest 0.1 foot. The Technical Enforcement Guidance Document (EPA, 1986) states that elevations should be taken to the nearest 0.01 foot to ensure accurate flow evaluations and to provide a check on the integrity of the well (e.g., identify siltation problems). The Task Force did note that well depths have become shallower, which may indicate that siltation has occurred (see Table 5).

- Wyman-Gordon has failed to adequately define bedrock characteristics through borings, and they have failed to determine whether bedrock is part of the uppermost aquifer.

- Vertical ground-water flow gradients for the bedrock and unconsolidated surficial deposits have not been determined.

- Wyman-Gordon's ground-water flow calculations appear to be based on average permeability of the unconsolidated sediments portion of the aquifer; however, flow may be occurring in discrete lithologic units of these sediments.

Ground-Water Sampling and Analysis Plan

Wyman-Gordon developed a sampling and analysis plan (SAP) in 1982 for the Phase I RCRA wells. The SAP has not been updated to reflect procedures the company may have followed since 1982, or what changes, if any, have been made in its analysis. Furthermore, the SAP does not address the Phase II or Phase III wells. The SAP should be revised to include these wells that are now used for background ~~monitor~~ing.

The SAP contains no sampling schedules for the background monitoring required by 40 CFR Part 265.92(c) and (d). At the time of the Task Force inspection, Wyman-Gordon had not established background concentrations quarterly for one year, or conducted semi-annual sampling following the initial year because they were conducting assessments.

The SAP is deficient in several other areas. No reference to field measurements such as pH, specific conductivity, temperature, and turbidity is made in the SAP. There is also no reference to a Laboratory Quality Assurance/Quality Control (QA/QC) program, nor a reference to field, trip, or equipment blanks taken for QA/QC purposes. No sample analyses request forms have been included.

The Task Force did not observe sampling by Wyman-Gordon; therefore, the Task Force could not determine whether company follows the SAP (as written).

A revision of the SAP should define the point of compliance, which should include both the North and South lagoons. The Part B permit application incorrectly defines the hazardous waste management area to include only the South lagoon.

Not all the quarterly sample parameters (as required by 40 CFR Part 215.93 (d)(7) are included in the SAP.

Sampling Analysis and Data Quality Evaluation

Interim status ground-water monitoring data collected by Wyman-Gordon between July 1982 and July 1986 (the time of the inspection) has been very limited (See Appendix E). Ground-water assessment was initiated upon the completion of one sampling round in July 1982, and no quarterly background concentrations have been established for one year. Wyman-Gordon also did not specifically confirm its operative assumption that the lagoons were affecting ground-water quality.

TABLE 4

MONITORING WELL CONSTRUCTION DATA[1]

Well Number	Date Completed	Total Depth From GSE[2] (ft.)	GSE (msl)[2]	TOC[3] (msl)	Casing Type[4]	Screen Type	Screen (ft.)	Seal Thicknes (ft.)
GZA-1	6/18/82	36.5	372.8	375.65	PVC	PVC	24.8	1.1
GZA-2	6/21/82	22.3	373.6	376.3	PVC	PVC	14.9	.9
GZA-3	6/22/82	23.2	369.6	372.1	PVC	PVC	14.9	1.1
GZA-4	6/22/82	23.6	363.9	363.9	PVC	PVC	19.1	.7
GZA-5	8/23/82	26.3	369.7	371.1	PVC	PVC	19.8	1.7
GZA-5A	8/27/82	3.4	366.0	369.45	SS	SS	2.9	NONE
GZA-6	8/19/82	35.7	367.6	369.1	PVC	PVC	29.7	1.8[7]
GZA-6A	8/27/82	5.4	364.8	368.3	SS	SS	4.9	NONE
GZA-7	8/23/82	33.7	360.7	363.3	PVC	PVC	29.7	.6
GZA-8	8/17/82	42.6	357.3	358.8	PVC	PVC	39.6	1.2
GZA-9	8/27/82	5.2	357.4	361.05	SS	SS	4.7	NONE
GZA-10	6/18/84	40.0	374.6	[5]	PVC	PVC	24.5[6]	.5[8]
GZA-11	8/1/84	25.5	[5]	[5]	PVC	PVC	25.3[6]	.5[9]
GZA-12	8/3/84	23.5	[5]	[5]	PVC	PVC	15.0	.5[9]

Notes:

1 Source: Wyman-Gordon well construction logs.
2 GSE: ground surface elevation; msl: mean sea level.
3 Top of casing.
4 SS: stainless steel; PVC: polyvinylchloride.
5 Unknown; no information on well log.
6 Approximate length; unclear from logs.
7 Bentonite and "miscellaneous backfill."
8 Concrete surface seal only.
9 Bentonite surface seal.

TABLE 5
COMPARISON OF WELL DEPTHS

Well:	Task Force Total Well Depth* (ft)	Initial Total Well Depth* (ft)
GZA-1	38.08	39.35
GZA-2	22.18	23.3
GZA-3	22.41	23.0
GZA-4	20.17	20.6
GZA-5	24.02	25.7
GZA-5A	6.11	6.85
GZA-6	33.46	33.9
GZA-6A	8.18	8.9
GZA-7	35.14	36.3
GZA-8	40.86	44.0
GZA-9	8.10	8.85
GZA-10	33.47	34.0
GZA-11	26.68	25.3
GZA-12	17.35	17.6

Note:

* **Measured from top of casing.**

Sampling conducted by Wyman-Gordon has been limited to the following:

- o July 1982 and September 1982 for wells GZA-1 through GZA-4. Analysis included drinking water parameters, ground-water quality parameters, ground-water contamination parameters, and other parameters (nickel, turbidity) (see Appendix E).
- o GZA-10, 11, 12, were sampled once in 1984.
- o One additional well (GZA-6) was sampled quarterly in 1985.
- o Two wells (GZA-6 and GZA-11) were sampled during the first two quarters of 1986.

The Task Force has, therefore, determined that Wyman-Gordon has failed to meet the requirements of 40 CFR 265.93 (d)(4), as required by 265.93 (d)(7).

GROUND-WATER MONITORING PROGRAM PROPOSED FOR RCRA PART B PERMIT

On June 3, 1985, Wyman-Gordon notified MDEQE that the facility intended to discontinue using the RTF Lagoons, and to close them in compliance with RCRA closure standards. Wyman-Gordon also indicated that since such closure would not occur prior to November 8, 1985 (the date by which Section 3005(e) of RCRA required the submission of a permit application for a final determination regarding land disposal facilities), Wyman-Gordon would submit a Part B permit application focusing primarily on closure of the RTF Lagoons. The company submitted the application on November 8, 1985.

Because the RCRA application was submitted after assessment was initiated, a ground-water monitoring program was outlined for compliance monitoring. However, the following deficiencies existed in the Part B permit application:

- o 40 CFR Part 270.14(c)(2) -- The facility has not adequately characterized the site hydrogeology and uppermost aquifer.
- o 40 CFR Part 270.14(c)(4) -- The facility has not adequately defined the extent of ground-water contamination from the RTF lagoons.
- o 40 CFR Part 270.14(c)(4)(ii) -- The facility has not sampled ground water for all Appendix VIII hazardous constituents.
- o 40 CFR Part 270.14(c)(7) -- The facility has not submitted sufficient data to establish a compliance monitoring program or an engineering feasibility plan for a corrective action program.
- o 40 CFR Part 264.95 -- The waste management area does not include the North RTF lagoon.
- o 40 CFR Part 264.97 -- Existing monitoring wells are not properly constructed to ensure the integrity of ground-water samples (i.e., lack of concrete seals, excessive screen lengths).
- o 40 CFR Part 264.94(b)(1) -- The alternate concentration limits demonstration is inadequate since the site is not properly characterized in terms of its hydrogeochemistry.

EVALUATION OF MONITORING DATA FOR INDICATIONS OF WASTE RELEASE

Analytical results for the samples collected by Task Force personnel are presented in Appendix A. In general, the data (Table 12) indicates that hazardous waste constituents from the RTF lagoons have leaked into the ground water.

Total and Dissolved Metals

Total and dissolved metals analysis on Task Force samples show levels of arsenic, chromium, and lead above Interim Primary Drinking Water Standards (IPDWS) in well GZA-11. Arsenic exceeded the IPDWS in GZA-6, -6A, -4, and -12. Nickel was found to be above the ambient water quality criteria in GZA-11, -6A, -6, and -4. All of these contaminants have been used as indicators of lagoon effluent by Wyman-Gordon, and all of the above listed wells are downgradient of the RTF lagoons.

Task Force sample results generally agree with previous Wyman-Gordon sampling results; data shows the presence of lagoon effluent contaminants in downgradient monitoring wells.

Nitrate Nitrogen

High levels of nitrate nitrogen were found in three downgradient monitoring wells (GZA-6, -6A, -2) and the South lagoon water sample. This generally agrees with previous Wyman-Gordon results. In addition, the high level of nitrate nitrogen found in South lagoon water and downgradient further indicates that the RTF lagoons are impacting ground water.

TABLE 12

HAZARDOUS WASTE GROUND-WATER TASK FORCE SAMPLE RESULTS

Constituent	Sample Location (mg/L)								
	GZA-11	GZA-11 Dup[1]	GZA-6A	GZA-6A Dup[1]	GZA-4	GZA-12	GZA-2	GZA-C	La
Total Arsenic (.05)[2]	1.0	1.1	--[3]	.55	.07	.68	--	--	
Dissolved Arsenic	.64	.64	--	.19	.077	--	--	--	
Chromium (.05)[2]	--	.054	--	--	--	--	--	--	
Lead (.05)[2]	.109	0.78	--	--	--	--	--	--	
Nickel (.01)[4]	.020	.028	.021	.033	.023	--	--	.030	
Nitrate (10)[2]	--	--	17.0	20.0	--	--	21.0	17.30	

Notes:

1 Dup = Duplicate sample

2 IPDWS: Interim Primary Drinking Water Standard, mg/L

3 -- Indicates constituent below standards.

4 Ambient Water Quality Criteria, mg/L.

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APPENDIX A

LAGOON WATER AND SLUDGE CHARACTERISTICS

TABLE A-1
LAGOON WATER CHARACTERISTICS

Constituent	Concentration (mg/L) Nov. 1983	Concentration (mg/L) June 1985
Aluminum	11	--
Arsenic	0.06	< .010
Barium	< 0.05	--
Cadmium	< 0.05	--
Chromium (Total)	< 0.093	.008
Cobalt	0.093	--
Copper	< 0.23	--
Iron	1.6	--
Lead	< 0.1	--
Manganese	0.40	--
Mercury	0.00047	--
Molybdenum	0.067	--
Nickel	0.4	.68
Selenium	< 0.01	--
Silver	< 0.05	--
Tin	< 1	--
Titanium	≤ 0.89	--
Vanadium	< 0.07	--
Zinc	1.1	--
pH (pH units)	--	7.4

Notes:

Source: Wyman-Gordon, 1985

-- Indicates not analyzed for.

< Means "less than."

TABLE A-2

TOTAL AND EP EXTRACT CONCENTRATIONS OF EP METALS FOR "NEW" SLUDGE, 1983

	Concentration in Sludge (mg/kg)[1]			
	Week 1	Week 2	Week 3	Week 4
Sampling Period	3/4-3/11	3/11-3/18	3/18-3/25	6/3-6/10
Total Metals				
Arsenic	<5.0[2]	<4.3	<5.7	<0.4
Barium	55	97	98	14
Lead	193	325	756	343
Mercury	13.9	23.6	39.0	44
Selenium	<5.0	<4.3	<5.7	<0.4
Silver	<8.0	37.03	38.6	2.8

	Concentrations in Extract (mg/L)[3]			
	Week 1	Week 2	Week 3	Week 4
EP Toxicity				
Arsenic	<0.005	<0.005	<0.005	<0.005
Barium	<4.0	<0.10	<0.10	<0.10
Lead	<0.10	<0.10	<0.10	<0.10
Mercury	<0.0005	<0.0005	<0.0005	<0.0005
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.02	<0.02	<0.02	<0.02

Notes:

Source: Wyman-Gordon, 1983, 1984.

1 mg constituent/kg total solids (parts per million).

2 < means "less than."

3 mg/L equals parts per million.

TABLE A-3

ANALYTICAL RESULTS OF NEW SLUDGE, 1983

	Week 1	Week 2	Week 3	Week 4
Sampling Period	3/4-3/11	3/11-3/18	3/18-3/25	6/3/-6/10
Item				
pH	6.8	9.5	8.1	8.6
Total Suspended Solids (%)	1.49	0.99	1.04	1.06
Total solids (%)	1.7	1.3	1.1	1.3
Total Metals (mg/kg)[1,2]				
Cadmium	8.9	<8.5	<11.5	6.2
Chromium	1,274	382	1,127	2,160
Chromium (VI)	71	46	73	45
Nickel	2,175	879	1,641	2,611
EP Toxicity (mg/L)				
Cadmium	<0.01	<0.01	<0.01	0.08
Chromium	0.52	<0.05	<0.05	0.63
Nickel	2.79	0.35	0.45	2.49
Total Cyanide (mg/kg)[1]	<12	--[3]	--	--
EP Cyanide (mg/L)	<0.01	--	--	--

Notes:

Source: Wyman-Gordon, 1983, 1984.

1 mg constituent/kg total solids.

2 Detection limits for metals analyses of sludge samples are a function of the weight of the sample aliquot used in the sample digestion procedure and the solids concentration of the sample; for this reason, the detection limit may vary from sample to sample for any given metal.

3 -- Indicates not analyzed for.

TABLE A-4

TOTAL AND EP EXTRACT CONCENTRATIONS OF EP METALS FOR "OLD" SLUDGE

Total Metals	Quadrant I	Quadrant II	Quadrant III	Quadrant IV
	Concentration in Sludge (mg/kg)[1]			
Arsenic	<0.6[2]	<0.5	<0.7	<0.7
Barium	29	38	24	35
Lead	194	204	234	260
Mercury	1.06	0.94	2.21	2.69
Selenium	<0.6	<0.5	<0.7	0.7
Silver	5.0	4.7	7.0	7.6

EP Toxicity	Quadrant I	Quadrant II	Quadrant III	Quadrant IV
	Concentration in Extract (mg/L)[3]			
Arsenic	<0.005	<0.005	<0.005	<0.005
Barium	0.20	0.20	0.10	0.20
Lead	0.10	0.10	0.10	0.10
Mercury	<0.0005	<0.0005	<0.0005	<0.0005
Selenium	<0.005	<0.005	<0.005	<0.005
Silver	<0.02	<0.02	<0.02	<0.02

Notes:

Source:. Wyman-Gordon, 1983.

1 mg metal/kg total solids (parts per million).

2 < Means "less than."

3 mg/L equals parts per million.

TABLE A-5

ANALYTICAL RESULTS FOR SOUTH LAGOON SLUDGE
"OLD" SLUDGE
(SAMPLES COLLECTED 3/18/83)

Parameter	Quadrant I	Quadrant II	Quadrant III	Quadrant IV
pH	10.2	10.8	11.7	11.7
Total Solids (%)	20.5	22.1	16.8	17.1
Total Metals (mg/kg)[1]				
Cadmium	4.0	3.8	3.1	4.8
Chromium	467	441	373	420
Chromium (VI)	3.4	10.0	8.9	10.5
Nickel	1,616	1,032	1,618	1,158
EP Toxicity (mg/L)				
Cadmium	<0.01	<0.01	<0.01	<0.01
Chromium	0.10	<0.05	<0.05	0.06
Nickel	6.72	4.16	2.52	2.31
Total Cyanide (mg/kg)[1]	<1.0	--[3]	--	--
EP Cyanide (mg/L)	<0.01	--	--	--

Notes:

Source: Wyman-Gordon, 1983.

1 mg constituent/kg total solids.

2 Detection limits for metals analyses of sludge samples are a function of the weight of the sample aliquot used in the sample digestion procedure and the solids concentration of the sample; for this reason, the detection limit may vary from sample to sample for any given metals.

3 -- Indicates not analyzed for.

APPENDIX B

ANALYTICAL RESULTS FOR HWGWTF SAMPLING
WYMAN-GORDON COMPANY

CASE NO: 6228

SAMPLE NO:		Q1292/MQA492	Q1316/MQA616	Q1299/MQA499	Q1315/MQA615	Q1295/MQA495
SAMPLE LOCATION:		WELL GZA-11	WELL GZA-11	WELL GZA-6A	WELL GZA-6A	
SAMPLE TYPE:		DUP	DUP	DUP	DUP	EQ. BLK
VOA	ACETONE	110	130	130	9.4 J	
	CHLOROFORM	4.2 J	4 J		1.9 J	
	METHYLENE CHLORIDE		3.2 J	3.7 J	1.9 J	
	TETRACHLOROETHANE	8	6.4	2.8 J	7.8	
	1,1,1-TRICHLOROETHENE	18	17	17	29	
	TOLUENE					
SEMI-	PHENOL					
VOA	BIS(2-ETHYLHEXYL)PHTHALATE		2 J			7.6 J
	DI-N-BUTYLPHTHALATE	2.6 J		3 J		4 J
	2-METHYLNAPHTHALENE		3.8 J	2.2 J	10 J	
PEST/	NO HITS					
PCB						
TIC-	NO HITS					
VOA-PT						
TIC-	2,4-DIMETHYLDECANE			(PUR 850) 12J		
SEMI-	DIMETHYLNAPHTHALENE				(PUR 937) 5 J	
VOA	2-PROPANOL,1-[2-(2-METHOXY-1-METHYLETHOXY)-1-METHYL					
	UNKNOWN	25 JB		34 J	10 J	13 J
	UNKNOWN					10 J
	UNKNOWN					22 J
	UNKNOWN					64 J
	UNKNOWN					90 J
	UNKNOWN					22 J
	UNKNOWN					27 J
	UNKNOWN					110 J
	UNKNOWN					120 J
	UNKNOWN					26 J
	UNKNOWN					23 J
	UNKNOWN					16 J
	UNKNOWN					15 J
TOTAL	ALUMINUM	14300	12000	1350	14400	127
METALS	ANTIMONY	68	80	10	13	
	ARSENIC	1030.00	1130	22.1	557	
	BARIUM	149			55	6
	BERYLLIUM					
	CADMIUM					
	CALCIUM	80300	75900	4990	1960	296
	CHROMIUM	41	54		23	
	COBALT					
	COPPER	445	428		55	
	IRON	53000	34500	443	7280	43
	LEAD	109	78		39	
	MAGNESIUM	8160	7620	282	578 Q	
	MANGANESE	402	434	19	228	
	MERCURY		0.4			

ALL CONCENTRATIONS ARE IN ug/L.

CASE NO: 6228

		01292/MOA492	01316/MOA616	01299/MOA499	01315/MOA615	01295/MOA495
SAMPLE NO:		01292/MOA492	01316/MOA616	01299/MOA499	01315/MOA615	01295/MOA495
SAMPLE LOCATION:		WELL GZA-11	WELL GZA-11	WELL GZA-6A	WELL GZA-6A	
SAMPLE TYPE:		DUP	DUP	DUP	DUP	EQ. BLK
	NICKEL	27				
	POTASSIUM	11100	10600	15600	7560	
	SELENIUM	5.00	5			
	SILVER					
	SODIUM	576000	306000	500000	548000	880
	THALLIUM					
	VANADIUM	254	236	23	222	
	ZINC	145	143	25	40	15
DISS. METALS	ALUMINUM	2240	2730	1160	9220	
	ANTIMONY	54	94		4.6	
	ARSENIC	643.00	646	20.9	198	
	BARIUM	86	75		13	5
	BERYLLIUM					
	CADMIUM					
	CALCIUM	89200	81100	4060	1060	348
	CHROMIUM		24			
	COBALT		17			
	COPPER	209	253		23	
	IRON	2560	3920		617	10
	LEAD		48		4.5	
	MAGNESIUM	6690	6420	336		
	MANGANESE	275	270		9	
	MERCURY					
	NICKEL	20	28	21	33	
	POTASSIUM	10400	8860	18000	6890	
	SELENIUM					
	SILVER					
	SODIUM	304000	318000	472000	564000	926
	THALLIUM					
	VANADIUM	148	173	33	222	
	ZINC	27	25			
INORG. INDIC.	AMMONIA NITROGEN	1600	1600		620	
	BROMIDE					
	CHLORIDE	134000	138000	126000	159000	
	CYANIDE	50	35	22	162	
	NITRATE NITROGEN	6000	7500	17000	20000	
	NITRITE NITROGEN					
	POC					
	POX	9		26	15	
	SULFATE	355000	335000	425000	445000	
	TOC	21000	26000	3900	11000	
	TOTAL PHENOLS	26	15	18	10	
	TOX	23	38	46	61	
	CARBONATE					
	BICARBONATE					

ALL CONCENTRATIONS ARE IN ug/L.

	SAMPLE NO:	01318/MQA618	01321/MQA621	01294/MQA494	01296\MQA496	01297/MQA497
	SAMPLE LOCATION:			GZA-12	LAGOON #1	GZA-6
	SAMPLE TYPE:	FIELD BLK	TRIP BLK			
VOA	ACETONE	18		24		38
	CHLOROFORM					
	METHYLENE CHLORIDE		1.6 J			1.7 J
	TETRACHLOROETHANE					2.9 J
	1,1,1-TRICHLOROETHENE					18
	TOLUENE					
SEMI-VOA	PHENOL		2.4 J			
	BIS(2-ETHYLHEXYL)PHTHALATE					
	DI-~~N~~-BUTYLPHTHALATE			2.8 J	3 JB	
	2-METHYLNAPHTHALENE					2 J
PEST/PCB	NO HITS					
TIC-VOA-PT	NO HITS					
TIC-SEMI-VOA	2,4-DIMETHYLDECANE					
	DIMETHYLNAPHTHALENE					
	2-PROPANOL,1-[2-(2-METHOXY-1-METHYLETHOXY)-1-METHYL				(PUR 920) 45J	
	UNKNOWN			19 JB		90 J
	UNKNOWN					
	UNKNOWN					
	UNKNOWN					
	UNKNOWN					
	UNKNOWN					
	UNKNOWN					
	UNKNOWN					
	UNKNOWN					
	UNKNOWN					
	UNKNOWN					
	UNKNOWN					
	UNKNOWN					
TOTAL METALS	ALUMINUM	316		6240	2280	1380
	ANTIMONY					7
	ARSENIC			168.5		14.5
	BARIUM	9	4	84	6	4
	BERYLLIUM					
	CADMIUM					
	CALCIUM	351	160	30400	7470	4290
	CHROMIUM					
	COBALT			16		
	COPPER			23		
	IRON	41	22	78000	225	365
	LEAD	3		12		
	MAGNESIUM			11500 Q	692	282
	MANGANESE			440	11	25
	MERCURY					

ALL CONCENTRATIONS ARE IN ug/L.

CASE NO: 6228

	SAMPLE NO:	01318/MQA618	01321/MQA621	01294/MQA494	01296\MQA496	01297/MQA497
	SAMPLE LOCATION:			GZA-12	LAGOON #1	GZA-6
	SAMPLE TYPE:	FIELD BLK	TRIP BLK			
	NICKEL					
	POTASSIUM			5250	19200	15100
	SELENIUM					
	SILVER					
	SODIUM	830	603	20200	484000	500000
	THALLIUM					
	VANADIUM				146	
	ZINC	15		143	24	13
DISS.	ALUMINUM				2350	1210
METALS	ANTIMONY					
	ARSENIC					16.5
	BARIUM	7		28		
	BERYLLIUM					
	CADMIUM					
	CALCIUM	280	187	32700	8600	4150
	CHROMIUM					
	COBALT			18		
	COPPER				14	12
	IRON			268		12
	LEAD					
	MAGNESIUM			10400	855	368
	MANGANESE			325	10	
	MERCURY					
	NICKEL					30
	POTASSIUM			5170	21200	18800
	SELENIUM					
	SILVER					
	SODIUM	869	997	22000	528000	432000
	THALLIUM					
	VANADIUM				170	35
	ZINC					
INORG.	AMMONIA NITROGEN					
INDIC.	BROMIDE					
	CHLORIDE			30000	128000	125000
	CYANIDE					
	NITRATE NITROGEN			6000	31000	17000
	NITRITE NITROGEN					
	POC					
	POX	7				6
	SULFATE			25000	470000	425000
	TOC			7200	4000	4000
	TOTAL PHENOLS				14	
	TOX			8.6	44	56
	CARBONATE					
	BICARBONATE					

ALL CONCENTRATIONS ARE IN ug/L.

SAMPLE NO:		01300/MQA500	01314/MQA614	01319/MQA619	01320/MQA620
SAMPLE LOCATION:		GZA-10	GZA-4	GZA-3	GZA-2
SAMPLE TYPE:					
VOA	ACETONE	25	18	18	
	CHLOROFORM				
	METHYLENE CHLORIDE				
	TETRACHLOROETHANE			5.7	1.7 J
	1,1,1-TRICHLOROETHENE			7.6	9.5
	TOLUENE				2.3 J
SEMI-VOA	PHENOL				
	BIS(2-ETHYLHEXYL)PHTHALATE				
	DI-N-BUTYLPHTHALATE				2.4 J
	2-METHYLNAPHTHALENE				
PEST/PCB	NO HITS				
TIC-VOA-PT	NO HITS				
TIC-SEMI-VOA	2,4-DIMETHYLDECANE				
	DIMETHYLNAPHTHALENE				
	2-PROPANOL,1-[2-(2-METHOXY-1-METHYLETHOXY)-1-METHYL				
	UNKNOWN	16 J			
	UNKNOWN				
	UNKNOWN				
	UNKNOWN				
	UNKNOWN				
	UNKNOWN				
	UNKNOWN				
	UNKNOWN				
	UNKNOWN				
	UNKNOWN				
	UNKNOWN				
	UNKNOWN				
	UNKNOWN				
TOTAL METALS	ALUMINUM	1270	3840	3860	2220
	ANTIMONY				15
	ARSENIC	22.1	70	11.8	
	BARIUM	25	16	28	15
	BERYLLIUM				
	CADMIUM				
	CALCIUM	22500	4350	14700	5390
	CHROMIUM		35	15	
	COBALT				
	COPPER		15		
	IRON	8970	2370	2350	284
	LEAD				
	MAGNESIUM	2000	1540	3320	2160
	MANGANESE	1440	314	70	91
	MERCURY				0.2

ALL CONCENTRATIONS ARE IN ug/L.

CASE NO: 6228

SAMPLE NO:		Q1300/MQA500	Q1314/MQA614	Q1319/MQA619	Q1320/MQA620
SAMPLE LOCATION:		6ZA-10	6ZA-4	6ZA-3	6ZA-2
SAMPLE TYPE:					
	NICKEL				
	POTASSIUM	3210	6940	25400	15200
	SELENIUM				
	SILVER				
	SODIUM	11500	389000	492000	372000
	THALLIUM				
	VANADIUM		85	85	
	ZINC	68	27	35	16
DISS.	ALUMINUM		1290	156	1950
METALS	ANTIMONY				
	ARSENIC		77	16.1	
	BARIUM	20	4	5	13
	BERYLLIUM				
	CADMIUM				
	CALCIUM	25800	4970	15500	6280
	CHROMIUM				
	COBALT	20			
	COPPER		16		
	IRON	5390	11		23
	LEAD				
	MAGNESIUM	2120	1360	3180	2640
	MANGANESE	1550	326	15	101
	MERCURY				
	NICKEL		23		
	POTASSIUM	4040	7770	27200	16700
	SELENIUM				
	SILVER				
	SODIUM	12500	404000	400000	644000
	THALLIUM				
	VANADIUM		98	50	29
	ZINC	55	12	12	
INORG.	AMMONIA NITROGEN	140	330	200	1000
INDIC.	BROMIDE				
	CHLORIDE		300	600	11800
	CYANIDE				20
	NITRATE NITROGEN			140	21000
	NITRITE NITROGEN				
	POC				
	POX	9		10	10
	SULFATE		360000		460000
	TOC	4100	5800	3500	6800
	TOTAL PHENOLS		14	33	
	TOX	15	60	30	67
	CARBONATE				
	BICARBONATE				

ALL CONCENTRATIONS ARE IN ug/L.

prc

PRC Engineering

Planning Research Corporation

EVALUATION OF QUALITY CONTROL ATTENDANT TO THE ANALYSIS OF SAMPLES FROM THE WYMAN-GORDON FACILITY, MASSACHUSETTS

FINAL MEMORANDUM

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Waste Programs Enforcement
Washington, D.C. 20460

Work Assignment No.	:	548
EPA Region	:	Headquarters
Site No.	:	N/A
Date Prepared	:	November 7, 1986
Contract No.	:	68-01-7037
PRC No.	:	15-5480-03
Prepared By	:	PRC Environmental Management, Inc. Ken Partymiller
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PRIVILEGED WORK PRODUCT PREPARED IN ANTICIPATION OF LITIGATION

ENFORCEMENT CONFIDENTIAL

MEMORANDUM

DATE: November 5, 1986

SUBJECT: Evaluation of Quality Control Attendant to the Analysis of Samples from the Wyman-Gordon, Massachusetts Facility

FROM: Ken Partymiller, Chemist
PRC Environmental Management

THRU: Paul H. Friedman, Chemist*
Studies and Methods Branch (WH-562B)

TO: HWGWTF: Tony Montrone*
Gareth Pearson (EPA 8231)*
Richard Steimle*
Ed Berg (EPA 8214)*
Wayne Wirtanen, Region I
Steve Mangion, Region I

This memo summarizes the evaluation of the quality control data generated by the Hazardous Waste Ground-Water Task Force (HWGWTF) contract analytical laboratories (1). This evaluation and subsequent conclusions pertain to the data from the Wyman-Gordon, Massachusetts sampling effort by the Hazardous Waste Ground-Water Task Force.

The objective of this evaluation is to give users of the analytical data a more precise understanding of the limitations of the data as well as their appropriate use. A second objective is to identify weaknesses in the data generation process for correction. This correction may act on future analyses at this or other sites.

The evaluation was carried out on information provided in the accompanying quality control reports (2-3) which contain raw data, statistically transformed data, and graphically transformed data.

The evaluation process consisted of three steps. Step one consisted of generation of a package which presents the results of quality control procedures, including the generation of data quality indicators, synopses of statistical indicators, and the results of technical qualifier inspections. A report on the results of the performance evaluation standards analyzed by the

* HWGWTF Data Evaluation Committee Member

laboratory was also generated. Step two was an independent examination of the quality control package and the performance evaluation sample results by members of the Data Evaluation Committee. This was followed by a meeting (teleconference) of the Data Evaluation Committee to discuss the foregoing data and data presentations. These discussions were to come to a consensus, if possible, concerning the appropriate use of the data within the context of the HWGWTF objectives. The discussions were also to detect and discuss specific or general inadequacies of the data and to determine if these are correctable or inherent in the analytical process.

Preface

The data user should review the pertinent materials contained in the accompanying reports (2-3). Questions generated in the interpretation of these data relative to sampling and analysis should be referred to Rich Steimle of the Hazardous Waste Ground-Water Task Force.

I. Site Overview

No site background information was available to the HWGWTF Data Evaluation Committee teleconference concerning the Wyman-Gordon facility.

Fourteen field samples including one field blank (MQA618/Q1318), one trip blank (MQA621/Q1321), one equipment blank (MQA495/Q1295), and two pairs of duplicate samples (well GZA-11, MQA492/Q1292 and MQA616/QA1316 and well GZA-6A, MQA499/Q1299 and MQA615/Q1315) were collected at this facility. All samples were low concentration ground water samples. Traffic reports indicated which samples were blanks and duplicates.

II. Evaluation of Quality Control Data and Analytical Data

1.0 Metals

1.1 Performance Evaluation Standards

Metal analyte performance evaluation standards were not evaluated in conjunction with the samples collected from this facility.

1.2 Metals QC Evaluation

Metal spike recoveries were calculated for the twenty-three total metals and seventeen dissolved metals spiked into one field sample. Eighteen total metal and fifteen dissolved metal spike recoveries were within the data quality objectives (DQO) for this Program. The total aluminum and iron and dissolved calcium and sodium spike recoveries were not required to be calculated because the concentrations of these metals in the field sample were greater than four times the concentration of the spike added. Recoveries of the six dissolved metal spikes analyzed by graphite furnace atomic absorption analysis were not required to be reported and were not reported. The total selenium and thallium spike recoveries were below DQO with recoveries of 55 and 70 percent, respectively. The total cadmium spike recovery was above DQO with a recovery of 166 percent. All reported laboratory control sample (LCS) recoveries except arsenic and all calibration verification standard (CVS) recoveries were within Program DQOs.

The average relative percent differences (RPDs) for all metallic analytes were within the DQOs.

Required analyses were performed on all metals samples submitted to the laboratory.

No contamination was reported in the laboratory blanks. Equipment, field, and trip blanks show total metal contamination including aluminum (concentrations as high as 316 ug/L in the field blank), barium (as high as 9 ug/L in the field blank), calcium (as high as 351 ug/L in the field blank), iron (as high as 43 ug/L in the equipment blank), lead (3 ug/L in the field blank), sodium (as high as 880 ug/L in the equipment blank), and zinc (15 ug/L in the equipment and field blanks). Blanks also contained dissolved metal contamination including barium (as high as 7 ug/L in the field blank), calcium (as high as 348 ug/L in the equipment blank), iron (10 ug/L in the equipment blank), and sodium (as high as 997 ug/L in the trip blank). Only the total aluminum contamination was present at above the CRDL.

1.3 Furnace Metals

The differences between the results for the pairs of field duplicate were large for total arsenic, dissolved arsenic, and total lead in duplicate pair MQA499/615 and for total and dissolved lead in duplicate pair MQA492/616. The comparative precision of the field duplicate results is not used in the evaluation of sample data as it is not possible to determine the source of this imprecision. Field duplicate precision is reported for informational purposes only.

The total cadmium (166 percent recovery), selenium (55 percent), and thallium (70 percent) spike recoveries, as mentioned above, were outside DQO.

Method of standard addition (MSA), correlation coefficients for total antimony in sample MQA615, dissolved antimony in samples MQA492, 615, and 616 (duplicate analysis), and total arsenic in samples MQA494 and 614 were less than 0.995. The specified antimony and arsenic results for the above samples, except for antimony in samples MQA615 (total) and 616 (dissolved duplicate), should be considered qualitative. Results for total antimony in sample MQA615 and dissolved antimony in sample MQA616 (duplicate only) should be considered unreliable.

The duplicate injection precision for total antimony in samples MQA497 and 620 and in spiked samples MQA495 and 497 had relative standard deviations (RSDs) which were outside DQO. The duplicate injection readings for total arsenic in spiked sample MQA620 had an RSD which was outside DQO. The duplicate injection readings for dissolved lead in both sample and in spiked sample MQA492 had RSDs which were outside DQO. Specified results for all of these samples should be considered unreliable.

Traffic reports for samples MQA500 and 618 were not included in the data package.

Lead, antimony, and arsenic results, all with exceptions listed below, should be considered quantitative. Total lead results for samples MQA492 and

616 and all cadmium, thallium, and selenium results should be considered semi-quantitative. All (total and dissolved) arsenic results for sample MQA494 should be considered qualitative. Total antimony results for sample MQA615, dissolved antimony results for samples MQA492 and 615, all antimony results for samples MQA495, 497, and 620, dissolved lead results for sample MQA492, and total and dissolved arsenic results for sample MQA614 should be considered unreliable.

1.4 ICP Metals

The differences between field duplicate results were large for total and dissolved aluminum, iron, potassium, and vanadium and total chromium and copper in duplicate pair MQA499/615 and r total and dissolved chromium and iron and total sodium in duplicate pair MQA492/616. The comparative precision of the field duplicate results is not used in the evaluation of sample data as it is not possible to determine the source of this imprecision. Field duplicate precision is reported for informational purposes only. Background ion (aluminum, iron, potassium, etc.) results are measured and reported mainly to describe general ground water conditions.

Aluminum was found in the field blank (MQA618) at a concentration of 316 ug/L. This is above the aluminum CRDL of 200 ug/L. All other field blank contamination was at levels below CRDL.

High sulfate concentrations were reported for samples MQA492, 496, 497, 499, 614, 615, 616, and 620. High sulfate concentrations could suppress the barium results in these samples, although the quality control information supplied with this and past cases does not indicate such interference.

The low level (twice CRDL) linear range checks for chromium, manganese, nickel, and silver had low recoveries. The low level linear range check for zinc had a high recovery. All total and dissolved chromium, manganese, nickel, and silver results should be considered to be biased low. All zinc results should be considered to be biased high.

All total and dissolved barium, beryllium, calcium, cobalt, copper, iron (with exceptions), magnesium, manganese, potassium, sodium, vanadium results, all dissolved aluminum results, and total aluminum results for samples MQA492, 494, 614, 615, 616, and 619 should be considered quantitative. All chromium, nickel, silver, and zinc results, iron results for samples MQA492, 494, and 616, and all total aluminum results not mentioned above should be considered semi-quantitative.

1.5 Mercury

Mercury results for duplicate sample pair MQA492/616 had a greater absolute difference than expected (one sample had none detected and the other 0.4 ug/L). The comparative precision of the field duplicate results is not used in the evaluation of sample data as it is not possible to determine the source of this imprecision. Field duplicate precision is reported for informational purposes only.

All total and dissolved mercury results should be considered quantitative.

2.0 Inorganic and Indicator Analytes

2.1 Performance Evaluation Standard

Inorganic and indicator analyte performance evaluation standards were not evaluated in conjunction with the samples collected from this facility.

2.2 Inorganic and Indicator Analyte QC Evaluation

The average spike recoveries of all of the inorganic and indicator analytes were within the accuracy DQOs for all analytes (accuracy DQOs have not been established for bromide and nitrite nitrogen matrix spikes but their average recoveries were 100 and 98 percent, respectively). This indicates acceptable recoveries for all these analytes. All LCS and CVS recoveries reported in the raw data for inorganic and indicator analytes were within Program DQOs except for two continuing calibration verifications (CCVs) for the ammonia nitrogen analysis.

Average RPDs for all inorganic and indicator analytes were within Program DQOs. Precision DQOs have not been established for bromide and nitrite nitrogen.

Requested analyses were performed on all samples for the inorganic and indicator analytes.

No laboratory blank contamination was reported for any inorganic or indicator analyte. POX was detected in the field blank (MQA618) at a concentration of 7 ug/L.

2.3 Inorganic and Indicator Analyte Data

The quality control results for sulfate, chloride, total phenols, and TOC data are acceptable. The results for these analytes should be considered quantitative.

The cyanide calibration curve was improperly derived from the calibration data. The results of the initial calibration verification (ICV), the laboratory control standard (LCS), and sample MQA615 were read from the rejected, non-linear portion of this calibration curve. All analyses, including blanks and calibration verifications, should fall within the linear range of the calibration curve. An EPA verification standard was not available for cyanide and, thus, the laboratory prepared and used their own. A CCV and CCB were not run at the end of the cyanide analytical batch affecting samples MQA492DUP, 499DUP, and 620DUP. The absolute difference between the results for one of the two pairs of field duplicates (22 ug/L for sample MQA499, 162 ug/L for sample MQA615) was greater than expected. The comparative precision of the field duplicate results is not used in the evaluation of sample data as it is not possible to determine the source of this imprecision. Field duplicate precision is reported for informational purposes only. The cyanide results should be considered semi-quantitative except for samples MQA492 and 616 which should be considered quantitative.

The holding times for the nitrate nitrogen analyses ranged from 22 to 23 days from receipt of samples which is significantly longer than the recommended

48 hour holding time for unpreserved samples The nitrate nitrogen results should be considered semi-quantitative.

An initial calibration verification was not analyzed at the beginning of the bromide analysis. Analysis of a calibration verification standard, using an EPA or independent standard, should be performed before sample analysis. Bromide data for all samples were acceptable and the results should be considered semi-quantitative.

An initial calibration verification was not analvzed at the beginning of the nitrite nitrogen analysis. Analysis of a calibration verification standard, using an EPA or independent standard, should be performed before sample analysis. The holding times for the nitrite nitrogen analyses were 22 to 23 days from receipt of samples which is significantly longer than the recommended 48 hour holding time for unpreserved samples. Nitrite nitrogen data for all samples was acceptable and the results should be considered semi-quantitative.

Two ammonia nitrogen CCVs were above DQO. The absolute difference between the ammonia nitrogen results for one of the two duplicate pairs was large (none reported for sample MQA499 and 620 ug/L was reported for sample MQA615). The comparative precision of the field duplicate results is not used in the evaluation of sample data as it is not possible to determine the source of this imprecision. Field duplicate precision is reported for informational purposes only. Ammonia nitrogen results should be considered semi-quantitative.

The daily TOC instrument calibration data encompassing the expected concentration ranges of the samples were not supplied with the raw data by the laboratory. The TOC RPD results for both pairs of field duplicate samples were greater than expected (21 mg/L for sample MQA492 and 26 mg/L for sample MQA616, 3.9 mg/L for sample MQA499 and 11 mg/L for sample MQA615). The comparative precision of the field duplicate results is not used in the evaluation of sample data as it is not possible to determine the source of this imprecision. Field duplicate precision is reported for informational purposes only. The TOC results, as mentioned above, should be considered quantitative.

No initial calibration verifications (ICVs) or continuing calibration verifications (CCVs) were analyzed for POC. A spike solution was analyzed after 13 samples but the "true" concentration of this solution was not reported and thus instrument calibrations could not be assessed. Calibration curve information was not provided by the laboratory with the raw data. The POC results should be considered qualitative.

Instrument calibration data for TOX were not found for any of the analytical batches. Instrument calibration, with standards that embrace the expected range of concentrations of the samples, is required to be performed daily. Calibration verification standards and blanks should also be analyzed every 10 samples and at the beginning and end of each day's analyses. These standards were not analyzed at the end of analysis batches affecting samples MQA494 and 495, the spikes for samples MQA616 and 620, and the duplicate for sample MQA500. A final calibration standard was not run. The differences in the TOX results for both pairs of field duplicate samples were greater than expected (23 ug/L for sample MQA492 and 38 ug/L for sample MQA616, 46 ug/L for sample MQA499 and 61 ug/L for sample MQA615). The comparative precision of the field duplicate results is not used in the evaluation of sample data as it is not possible to determine the source of this imprecision. Field duplicate precision is reported for informational purposes only. The TOX results should be considered to be quantitative except for samples MQA494 and 495 which should be considered semi-quantitative.

A three point calibration curve for POX was not included in the raw data. POX was found in the field blank at 7 ug/L which is above the CRDL of 5 ug/L. The absolute differences between the POX results for both of the duplicate pairs was larger than expected (9 ug/L for sample MQA492 and none reported for sample MQA616, 26 ug/L for sample MQA499 and 15 ug/L for sample MQA615). The comparative precision of the field duplicate results is not used in the evaluation of sample data as it is not possible to determine the source of this imprecision. The field duplicate precision is reported for informational purposes only. The POX results should be considered unreliable except for samples MQA492 and 616 which should be considered qualitative.

3.0 Organics

3.1 Performance Evaluation Standard

Organic performance evaluation standards were not evaluated in conjunction with the samples collected from this facility.

3.2 Organic QC Evaluation

All matrix spike average recoveries were within established Program DQOs for accuracy. Individual matrix spike recoveries which were outside the accuracy DQO will be discussed in the appropriate Section below. All surrogate spike average recoveries were also within DQOs for accuracy. Individual surrogate spike recoveries which were outside the accuracy DQO will be discussed in the appropriate Section below.

All matrix spike/matrix spike duplicate average RPDs were within Program DQOs for precision. Individual matrix spike RPDs which were outside the precision DQO will be discussed in the appropriate Section below. All average surrogate spike RPDs were also within DQOs for precision.

All organic analyses were performed as requested. Direct injection volatile, herbicide, and dioxin analyses were neither requested nor performed for any samples.

Laboratory blank contamination was reported for organics and is discussed in the appropriate Sections below.

Detection limits for the organic fractions are summarized in the appropriate Sections below.

3.3 Volatiles

Quality control data indicate that volatile organics were determined acceptably. The chromatograms appear acceptable. Initial and continuing calibrations, tunings, blanks, matrix spikes, matrix spike duplicates, and surrogate spikes were acceptable.

A minor mix-up was the only identified problem with the volatiles data. The traffic report submitted by the organic analytical laboratory indicated sample Q1318 was a trip blank and sample Q1321 was a field blank. According to the sampling contractor, the identification of these two samples was confused and Q1318 was the field blank and Q1321 was the trip blank. Data usability was not affected.

The volatiles data are acceptable. The probability of false negative results for the volatiles is acceptable. The estimated detection limits for the volatiles is the CRDL. The volatile compound results should be considered to be quantitative.

3.4 Semivolatiles

Calibrations, tunings, blanks, matrix spikes, matrix spike duplicates, surrogate spikes, and chromatograms were acceptable for the semivolatiles.

The surrogate recovery for 2-fluorophenol (DQO range, 21 to 100 percent) in sample Q1300 (16 percent) and 2,4,6-tribromophenol (DQO range, 10 to 123 percent) in samples Q1297 (126 percent), Q1299 (137 percent), and Q1315 (128 percent) were outside DQO.

A minor mix-up was identified with the semivolatiles data. The traffic report submitted by the organic analytical laboratory indicated sample Q1318 was a trip blank and sample Q1321 was a field blank. According to the sampling contractor, the identification of these two samples was confused and Q1318 was the field blank and Q1321 was the trip blank. Data usability was not affected.

The semivolatile data are acceptable and the results should be considered semi-quantitative. This is the expected capability and performance for this method. The probability of false negative results is acceptable. Estimated detection limits were twice CRDL for all samples.

3.5 Pesticides

The initial and continuing calibrations, blanks, and chromatographic quality for pesticides were acceptable. The matrix spike, matrix spike duplicate, and surrogate data were within acceptable limits.

Table 1 of Reference 3 (for organic analyses) lists samples containing methoxychlor peaks in their chromatograms. These peaks were within the retention time windows of methoxychlor and the organic laboratory should have, but did not, run confirmation analysis.

A minor mix-up was identified with the pesticides data. The traffic report submitted by the organic analytical laboratory indicated sample Q1318 was a trip blank and sample Q1321 was a field blank. According to the sampling contractor, the identification of these two samples was confused and Q1318 was the field blank and Q1321 was the trip blank. Data usability was not affected.

The estimated method detection limits for the pesticides fraction were CRDL for all samples. The pesticides data should be considered to be usable with the considerations noted with the possible exception of methoxychlor results. There is an enhanced probability of false negatives for pesticides due to the failure of the organic laboratory to identify some peaks within the pesticides retention time window.

III. Data Usability Summary

4.0 Graphite Furnace Metals, total

Quantitative: antimony, arsenic, and lead results, all with exceptions
Semi-quantitative: lead results for samples MQA492 and 616, all cadmium, thallium, and selenium results
Qualitative: arsenic results for samples MQA494 and 614
Unreliable: antimony results for samples MQA495, 497, 615 and 620

4.1 Graphite Furnace Metals, dissolved

Quantitative: antimony, arsenic, and lead results, all with exceptions
Semi-quantitative: all cadmium, thallium, and selenium results
Qualitative: arsenic results for samples MQA494 and 614
Unreliable: lead results for sample MQA492 and antimony results for sample QA615

4.2 ICP Metals, total

Quantitative: all barium, beryllium, calcium, cobalt, copper, magnesium, manganese, sodium, potassium, and vanadium results, aluminum results for samples MQA492, 494, 614, 615, 616, and 619, iron results with exceptions
Semi-quantitative: all chromium, nickel, silver, and zinc results, aluminum results with the above exceptions, iron results for samples MQA492, 494, and 616

4.3 ICP Metals, dissolved

Quantitative: all aluminum, barium, beryllium, calcium, cobalt, copper, magnesium, manganese, sodium, potassium, and vanadium results, iron results with exceptions
Semi-quantitative: all chromium, nickel, silver, and zinc results, iron results for samples MQA492, 494, and 616

4.4 Mercury, total and dissolved

Quantitative: all mercury data

4.5 Inorganic and Indicator Analytes

Quantitative: all sulfate, chloride, total phenol, and TOC results, all TOX results except samples MQA494 and 495
Semi-quantitative: cyanide, nitrate nitrogen, nitrite nitrogen, bromide, ammonia nitrogen, and TOX results for samples MQA494 and 495
Qualitative: all POC results and POX results for samples MQA492 and 616
Unreliable: POX results with the above exceptions

4.6 Organics

Quantitative: all volatiles and semivolatiles results
Pesticides: see Section 3.5

IV. References

1. Organic Analyses: CompuChem Laboratories, Inc.
P.O. Box 12652
3308 Chapel Hill/Nelson Highway
Research Triangle Park, NC 27709
(919) 549-8263

Inorganic and Indicator Analyses:
Centec Laboratories
P.O. Box 956
2160 Industrial Drive
Salem, VA 24153
(703) 387-3995

2. Draft Quality Control Data Evaluation Report for Wyman-Gordon, Massachusetts, 10/7/1986 and revised 10/20/86, Prepared by Lockheed Engineering and Management Services Company, Inc., for the US EPA Hazardous Waste Ground-Water Task Force.

3. Draft Inorganic Data Usability Audit Report and Draft Organic Data Usability Report, for the Wyman-Gordon, Massachusetts site, Prepared by Laboratory Performance Monitoring Group, Lockheed Engineering and Management Services Co., Las Vegas, Nevada, for US EPA, EMSL/Las Vegas, 10/7/1986, Draft Inorganic Data Usability Report revised, 10/20/86.

V. **Addressees**

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APPENDIX C

BORING LOGS FOR MONITORING WELLS

GOLDBERG · ZOINO & ASSOC., INC GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT WYMAN-GORDON NO. GRAFTON, MASSACHUSETTS	REPORT OF BORING NO GZA- SHEET 1 OF 2 DATE 6/18/82 FILE A-3288

BORING CO. Guild Drilling
FOREMAN C. Koehler
G-Z-A ENGINEER E. Clark

BORING LOCATION
GROUND ELEV. 372.8
DATE START 6/18/82 DATE END 6/18/82

CASING
SIZE: 3" (NW)
HAMMER: 300 lb
FALL: 24"

SAMPLER
TYPE Split Spoon OTHER
HAMMER 140 lb
FALL: 30"

GROUNDWATER READINGS			
DATE	DEPTH	CASING AT	STABILIZATION
6/18	9.3'	35'	½ hour
6/22	6.4'	OW	4 days

DEPTH	CAS. BL. /FT.	SAMPLE NO	PEN./REC.	SAMPLE DEPTH	BLOWS/6"	STRATA CHG and GEN. DESC.	SAMPLE DESCRIPTION Burmister CLASSIFICATION
	10	S-1	24/10	0-2	4-14-14-30	SAND (FILL)	Medium dense olive grey fine SAND, some(-) Silt, trace to little coarse Sand and fine to medium Gravel; 3" topsoil in top
	41						
	75						
	210						
	170						
5	45	S-2	24/15	5-7	28-30-25-25		Very dense brown grey fine to coarse SAND, trace to little fine to medium Gravel, trace Silt, trace red-brown rock fragments
	52						
	102					8.5'	
	71						
	46					FINE SAND LITTLE SILT	
10	15	S-3	24/1	10-12	16-11-9-6		Moist brown fine SAND, little(-) Silt
	17	S-3A	30/8	10-12.5	6		Loose wet grey brown fine to coarse SAND, some fine to coarse Gravel, trace Silt
	22						
	52						
	38						
15	6						
	10	S-4	24/6	16-18	5-6-8-11		Medium dense olive grey fine SAND, little(+) to some Silt, trace(+) fine to medium Gravel
	17					18'±	
	45					FINE SAND LITTLE GRAVEL (GLACIAL TILL)	
	65						
20	15	S-5	24/14	20-22	31-33-37-33		Very dense grey fine to medium SAND, little coarse Sand and fine to medium Gravel, little(+) Silt, very compact matrix
	8						
	9						
	8						
25	36						
	11	S-6	24/20	25-27	26-35-43-38		Very dense grey fine SAND, trace to little(-) fine to medium Gravel, little Silt
	16						
	6						
	4						
30	30						
		S-7	24/16	30-32	32-15-33-60		Very dense grey fine SAND, little to some fine to coarse Gravel, trace medium to coarse Sand, trace to little Silt

REMARKS:
1) 2" gravel piece in tip of spoon.
2) Cobble encountered 14.8'-15.5'±.
3) Wash ahead of casing from 22' to BOH.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF THE GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG · ZOINO & ASSOC., INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT WYMAN-GORDON NO. GRAFTON, MASSACHUSETTS	REPORT OF BORING NO. 32A- SHEET 2 OF 2 DATE 6/18/82 FILE A-328

DEP.	CAS. BL. /FT.	SAMPLE NO.	PEN./REC.	DEPTH	BLOWS/6"	STRATA CHNG and GEN. DESC.	SAMPLE DESCRIPTION
35						35.0'	
		S-8	5/2	35-35.4	150/3 (140#) 125/2 (300#)	36.5'	Rock fragments
							Bottom of Hole
40							

REMARKS: 4) Refusal to split spoon sampler encountered at 35.4'; drilled ahead using roller bit to 36.5 ft. Very slow progress observed, terminated boring at this depth 1.5'± into apparent bedrock.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF THE GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

WELL No GZA-1

BORING No GZA-1

FILE No A-3288

DATE INSTALLED June 18, 1982

PROJECT Wyman-Gordon

LOCATION No. Grafton, Massachusetts

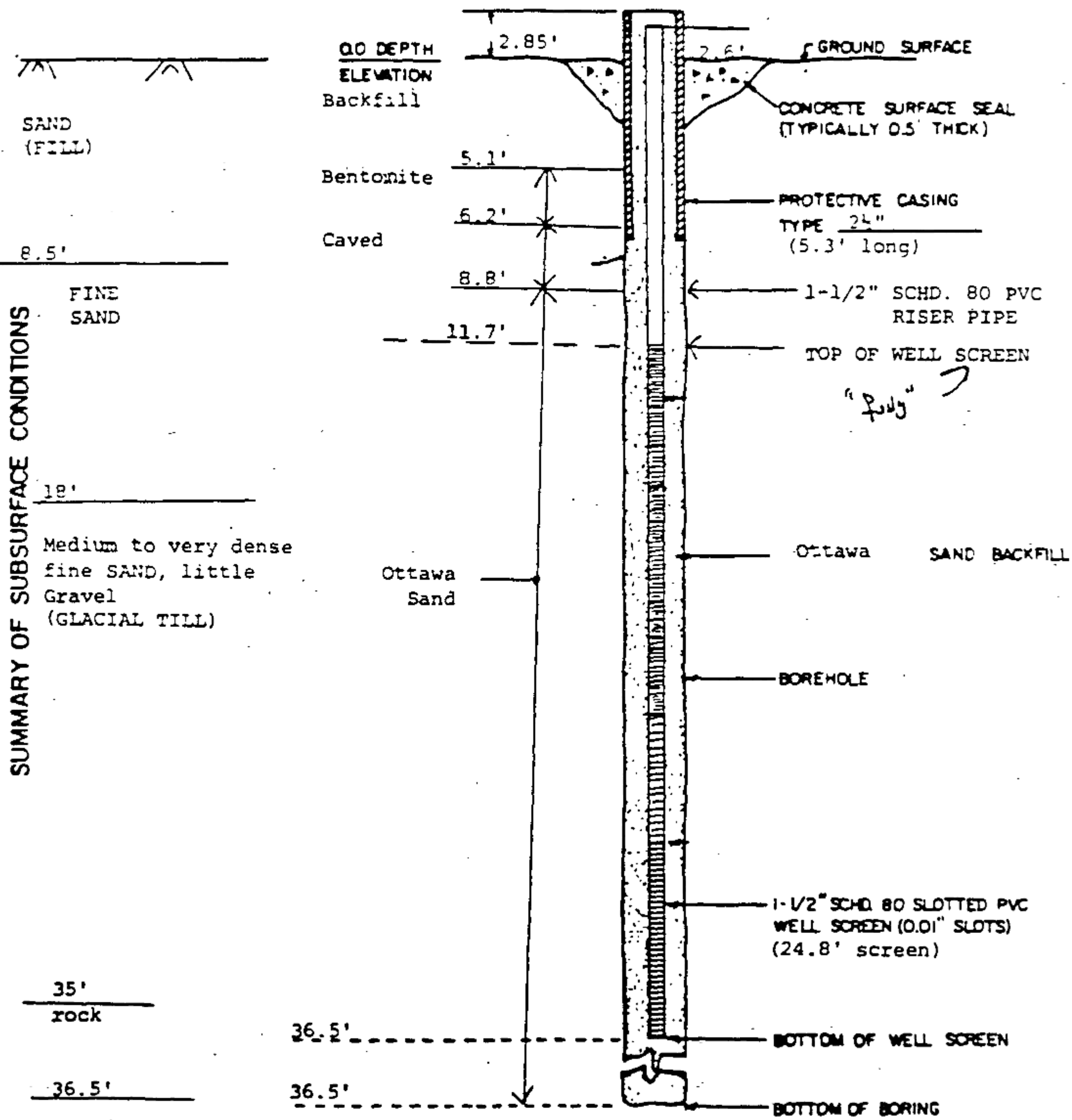
GZA ENGINEER F. Clark

CONTRACTOR Guild Drilling

WEATHER CONDITIONS Ptly cloudy, 70's

DRILLER C. Koehler

REMARKS See attached boring log



NOTE: NOT TO SCALE

DEPTH/ELEVATION BOTTOM OF BORING 36.5' / 336.3

DEPTH/ELEVATION BOTTOM OF WELL POINT 36.5' / 336.3

GOLDBERG-ZOINO & ASSOCIATES, INC.

GOLDBERG · ZOINO & ASSOC., INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT WYMAN-GORDON NO. GRAFTON, MASSACHUSETTS	REPORT OF BORING NO 22A SHEET 1 OF 1 DATE 6/21/82 FILE A-3288

BORING CO. Guild Drilling — BORING LOCATION Southeast of south lagoon

FOREMAN C. Koehler — GROUND ELEV 373.6

G-Z-A ENGINEER E. Clark — DATE START 6/21/82 — DATE END 6/21/82

CASING	SAMPLER	
SIZE 3" (NW)	TYPE Split Spoon	OTHER
HAMMER 300 lb	HAMMER 140 lb	
FALL 24"	FALL 30"	

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION
6/21	5.3'	20'	immed.

DEPTH	CAS. BL./FT.	SAMPLE NO	PEN./REC	DEPTH	BLOWS/6"	STRATA CHG and GEN DESC	SAMPLE DESCRIPTION Burmister CLASSIFICATION
	27	S-1	24/8	0-2	6-36-14-60	SAND (FILL) 5.0'	Dark brown loamy fine SAND, some Silt, trace coarse Sand and fine Gravel; Gravel predominant in bottom of sample, roots in upper 4"±
	59						
	72						
	61						
	150						
5	4	S-2	24/0	5-7	1-1-2-2	SANDY PEAT 7.5'	No recovery
	16						
	58	S-2A	24/16	7-9	7-35-55-71	FINE SAND 11.0'	4" of loose medium dense brown fine to coarse SAND, trace Silt 3" of dark brown muck with some fine to coarse SAND
	125						
10	137						
	11	S-3	24/10	10-12	52-48-37-24	GRAVEL AND SAND (GLACIAL TILL)	9" of mottled grey brown SILT, some fine Sand, grading to fine SAND, some Silt, some medium to coarse Gravel, then to dense fine to coarse GRAVEL, little fine Sand, little Silt
	25						
	37						
	50						
15	90						
			5/0	15-15.4	285/5"		Very dense brown grey fine to coarse GRAVEL and fine(+)to medium SAND, little Silt; gravel pieces are angular, with some red brown (oxidized) zones noted
20		S-4	24/4	20-22	11-5-8-20	22.0'	No recovery; refusal to split spoon at 15.4' Drill cobbles, boulders 15.4'-18,5'± Gravel fragments, some Sand
						22.3'	Rock
25							Refusal to sampler and roller bit at 22.3' Bottom of Hole

REMARKS: 1. 2" Gravel piece in tip of sampler; apparent cobbles at depth of 1.5 ft, so moved hole 2 ft± east prior to continuing.

2. Numerous cobbles encountered in upper 5 ft especially between 4.3 ft and 5.0 ft spun 4" casing through boulders to depth of 5 ft in order to advance.

3. Drilled ahead from 10 ft to BOH to advance casing.

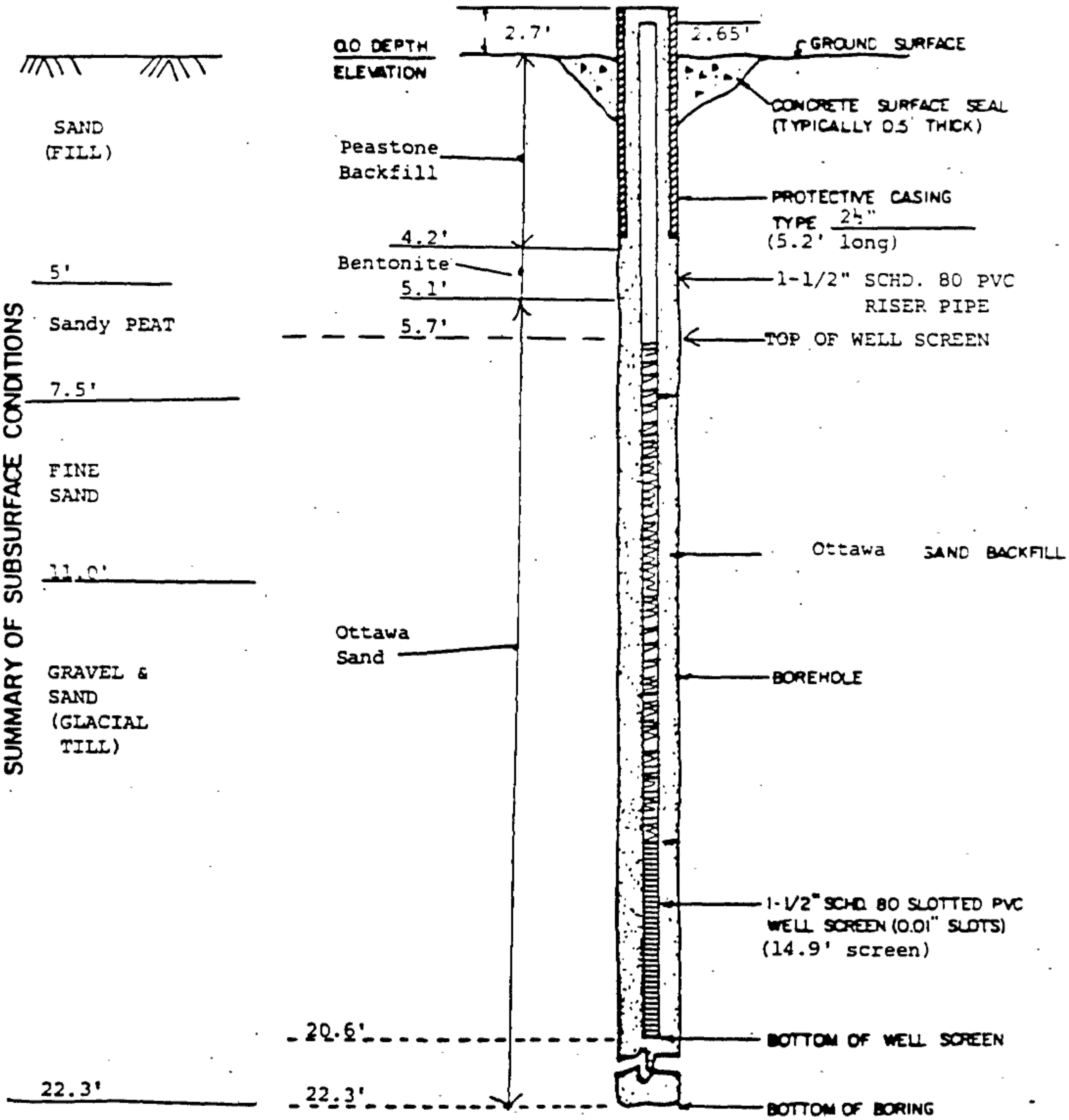
4. Used over 300 gal. drill water from 5 ft to 20 ft.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF THE GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

WELL No GZA-2
BORING No [illegible]
FILE No A-3288

DATE INSTALLED June 21, 1982

PROJECT Wyman-Gordon | LOCATION No. Grafton, Massachusetts
GZA ENGINEER E. Clark | CONTRACTOR Guild Drilling
WEATHER CONDITIONS intermeittent rain | DRILLER C. Koehler
REMARKS See attached boring log



NOTE: NOT TO SCALE

DEPTH/ELEVATION BOTTOM OF BORING 22.3' / 351.3

DEPTH/ELEVATION BOTTOM OF WELL POINT 20.6' / 353.0

GZA

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

GOLDBERG · ZOINO & ASSOC., INC GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT WYMAN-GORDON NO. GRAFTON, MASSACHUSETTS	REPORT OF BORING NO GZA- SHEET 1 OF 1 DATE 6/22/82 FILE A-3288

BORING CO. Guild Drilling
FOREMAN C. Koehler
G-Z-A ENGINEER E. Clark

BORING LOCATION Northeast of South Lagoon
GROUND ELEV 369.6
DATE START 6/22/82 DATE END 6/22/82

CASING
SIZE 3" (NW)
HAMMER 300 lb
FALL 24"

SAMPLER
TYPE Split Spoon OTHER
HAMMER 140 lb
FALL 30"

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION T
6/22	6.9'	out	15 minutes
6/22	6.1'	OW	1 hour

DEPTH	CAS. BL. /FT.	SAMPLE NO	PEN/REC.	DEPTH	BLOWS/6"	STRATA CHG and GEN DESC.	SAMPLE DESCRIPTION Burmister CLASSIFICATION
	4	S-1	24/14	0-2	2-2-6-20	TOPSOIL	6" of brown loamy fine SAND, some Silt, roots (TOPSOIL)
	16					SUBSOIL 1.5'	4" of yellow brown fine SAND, some (-) Silt, trace coarse Sand, trace roots
	63						
	140					SAND AND GRAVEL (FILL)	4" medium dense dry brown fine(+) to medium SAND, some fine to coarse Gravel, little(-) Silt.
	165						
5	5	S-2	24/8	5-7	34-49-70-38		
	21						
	47						Very dense wet grey brown medium to coarse GRAVEL, some(+) fine to coarse Sand, little Silt, some red brown zones noted; Gravel portion is angular to subangular
	56						
	49						
	62	S-3	24/11	10-12	21-30-22-26		
	35					12.0±	
	48					VERY DENSE GRAVEL & SAND (GLACIAL TILL)	
	125						
	66						
15		S-4	24/12	15-17	80-45-38-32		Wet very dense fine(+) to medium SAND, some (+) medium to coarse Gravel, little Silt
							3" similar to above, little Gravel, grading to medium dense grey brown fine SAND, little to some(-) Silt, trace fine Gravel & coarse Sand
20		S-5	24/14	20-22	15-11-10-11		
						22.9'	
					100/0"(300#)	23.2'	Rock
25							Refusal to roller bit and A-rod at 23.2'
							Bottom of Hole

REMARKS:
1. Drilled ahead from depth of 5 ft to BOH to advance casing.
2. Cobbles/boulders drilled from 12.5'± to 14.5'.
3. Apparent top of rock at 22'-10" (by driller): cannot penetrate with roller bit more then 4": confirmed refusal with A-rod.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF THE GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME [illegible]

WELL No GZA-3
BORING No GZA-3
FILE No A-3288

DATE INSTALLED June 22, 1982

PROJECT Wyman-Gordon

LOCATION No. Grafton, Massachusetts

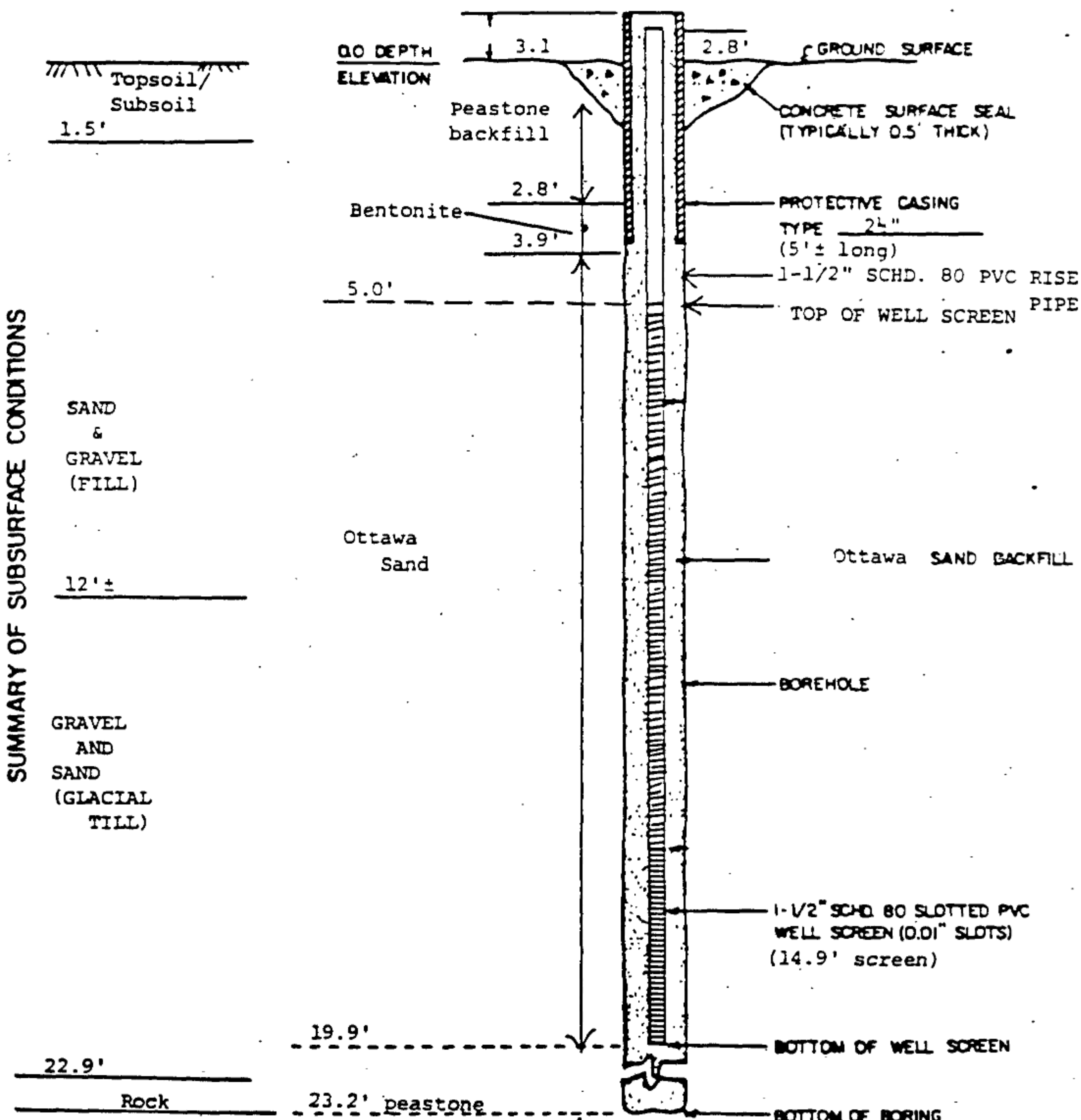
GZA ENGINEER F. Clark

CONTRACTOR Guild Drilling

WEATHER CONDITIONS sunny, 70's

DRILLER C. Koehler

REMARKS See attached boring log



NOTE: NOT TO SCALE

DEPTH/ELEVATION BOTTOM OF BORING 23.2' / 346.4

DEPTH/ELEVATION BOTTOM OF WELL POINT 19.9' / 349.7

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

[illegible] & ASSOCIATES, INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

WYMAN-GORDON
NO. GRAFTON, MASSACHUSETTS

REPORT OF BORING NO [illegible]
SHEET 1 OF [illegible]
DATE 6/22/8[illegible] FILE A-[illegible]

BORING CO Guild Drilling
FOREMAN C. Koehler
G-Z-A ENGINEER R. Clark

BORING LOCATION Northeast of North Lagoon
GROUND ELEV 363.9
DATE START 6/21/81 DATE END 6/22/82

CASING
SIZE 3" (NW)
HAMMER 300 lb
FALL 24"

SAMPLER
TYPE Split Spoon OTHER
HAMMER 140 lb
FALL 30"

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION TIME
6/22	2.7'	5'	18 hours

DEPTH	CAS. BL. /FT	SAMPLE NO	PEN./REC	DEPTH	BLOWS/6"	STRATA CHG and GEN. DESC.	SAMPLE DESCRIPTION Burmister CLASSIFICATION
		S-1	24/	0-2	2-4-17-10	TOPSOIL 1.0'	Loose brown loamy fine SAND, little Silt, roots
						SAND, SAND & GRAVEL 6.0'	Medium dense brown fine to coarse SAND, trace fine to coarse Gravel, little Silt
5	37	S-2	24/13	5-7	29-23-14-13		Dense brown fine to coarse GRAVEL and medium to coarse SAND, trace Silt (6") changing to
	30						
	42						
	75						
	140						medium dense brown fine SAND, little to some Silt, trace coarse Sand and fine Gravel; Gravel pieces are angular and brittle in upper 6"
10		S-3	24/10	10-12	19-65-60-33	DENSE SAND & GRAVEL (GLACIAL TILL)	
15		S-4	24/8	15-17	21-19-24-20		Medium dense brown fine(+) to medium SAND, little Silt, trace fine Gravel, grading to very dense fine(+) to coarse SAND, little fine to medium Gravel, trace(+) Silt
20		S-5	24/	20-22	15-17-32-38		Dense brown fine SAND, some fine to coarse GRAVEL with zones of fine to coarse SAND, some fine to coarse GRAVEL, little Silt; Gravel is angular to subangular in shape
						22.7'	Dense to very dense brown fine to medium SAND, little to some fine to coarse Gravel, little(-) Silt
						23.6'	Rock
25							Refusal to roller bit and A-rod at 23.5'
							Bottom of Hole

REMARKS:
1. Numerous cobbles & boulders encountered in upper 4 ft; spun 4" casing to 5 ft to penentrate fill & advance hole.
2. Apparent top of rock encountered at 22'-8"; drilled 10" into rock, very slow progress; confirmed refusal with A-rod.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF THE GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

WELL No GZA-4
BORING No GZA-4
FILE No A-3288

DATE INSTALLED June 23, 1982

PROJECT Wyman-Gordon

LOCATION North Grafton, Massachusetts

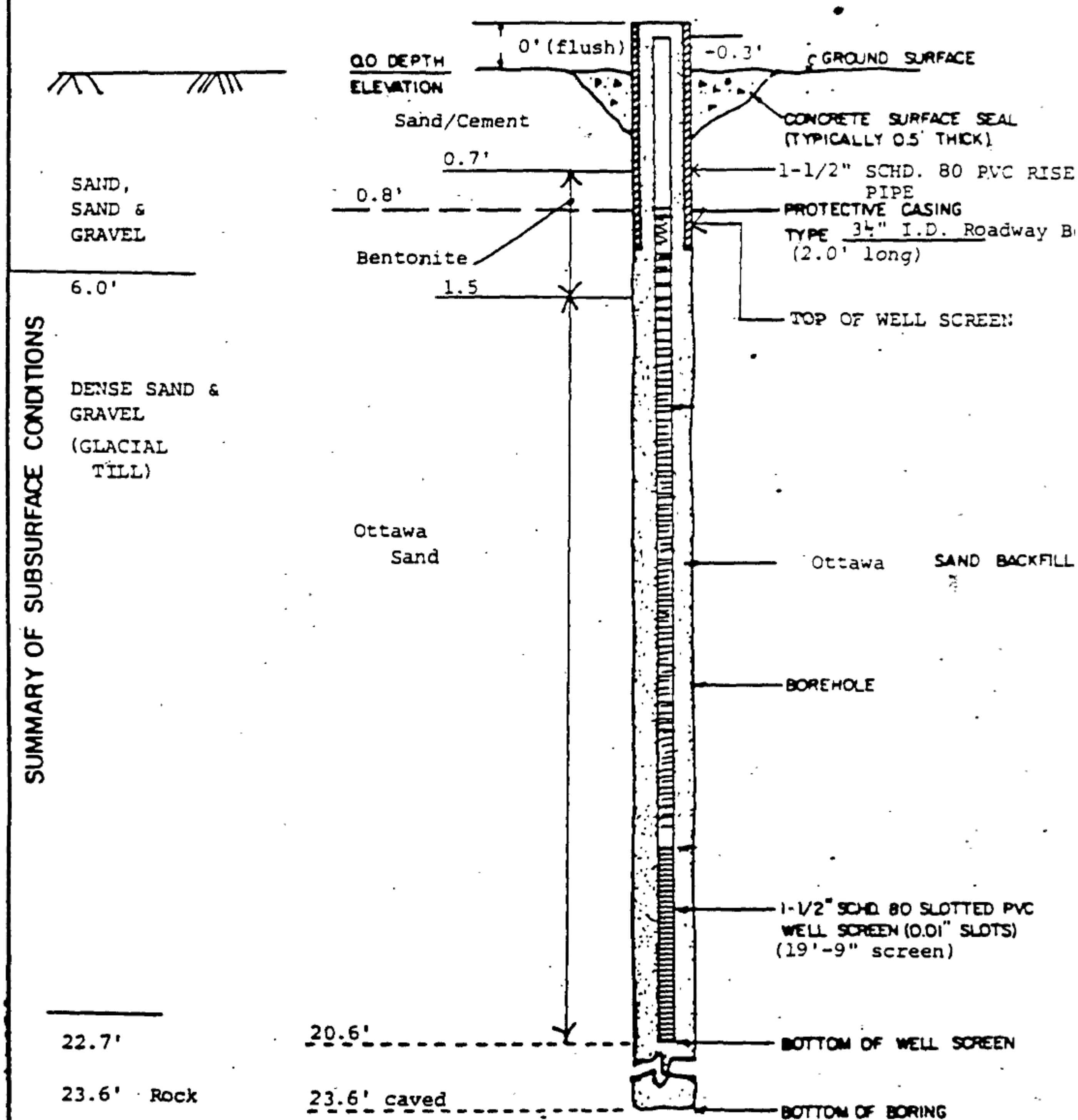
GZA ENGINEER F. Clark

CONTRACTOR Guild Drilling Co.

WEATHER CONDITIONS ptly sunny, 70's

DRILLER C. Koehler

REMARKS See attached boring log



NOTE: NOT TO SCALE

DEPTH/ELEVATION BOTTOM OF BORING 23.6' / 340.3

DEPTH/ELEVATION BOTTOM OF WELL POINT 20.6' / 343.3

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

GOLDBERG-ZOINO & ASSOCIATES, INC.
320 NEEDHAM ST, NEWTON UPPER FALLS, MA

GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT: WYMAN GORDON, NO GRAFTON MASSACHUSETTS

REPORT OF BORING No GZA-5
SHEET 1 OF 1
FILE No A-3288
CHKD BY

BORING Co. [illegible]
FOREMAN K. Allen
GZA ENGINEER F. Clark

BORING LOCATION
GROUND SURFACE ELEVATION
DATUM
DATE START 8/23/82
DATE END 8/23/82

SAMPLER UNLESS OTHERWISE NOTED SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140lb HAMMER FALLING 30 in

CASING UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300lb HAMMER FALLING 24 in.

CASING SIZE 4" (HW) to 9' OTHER: 3" (NW) to BOH

GROUNDWATER READINGS

DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
8/23	0930	3.2'	14'	1/2 hour
8/23	1400	3.1	OW	1 hour

DEPTH (ft)	CASING (bl/ft)	SAMPLE No.	PEN (in)/REC	SAMPLE DEPTH (ft)	BLOWS/6"	SAMPLE DESCRIPTION (BURMISTER CLASSIFICATION)	REMARKS	STRATUM DESCRIPTION
		S-1	18/3	0-1.5	3-5-9	Dark brown, loose, Loamy SILT, some fine Sand, trace Roots		1' TOPSOIL, LOAM
	30						1	Fine to coarse SAND (FILL)
	77							
	17							
	11							
5		S-2	24/6	5-7	36-19-34-65	Very dense, gray, fine+ to coarse SAND, little fine to medium Gravel, little Silt		
	--						2	7.0'±
	105							Fine to coarse SAND, little Grav[el] and Silt
	--							
	40	S-3	24/6	9-11	69-48-25-14	Very dense, gray-brown, fine to coarse SAND, trace fine Gravel and Silt		
10	29							
	20							
	17							
	21							
	--	S-4	24/8	14.5-16.5	23-16-17-11	Similar to above, medium dense to dense		
15	--							
	27							
	34							
	44							19'±
	24	S-5	24/3	19.5-21.5	22-21-18-13	Dense, gray, fine SAND, little to some Silt, little+ fine to coarse Gravel fragments		Dense, fine SAND, little Silt and Gravel fragments (GLACIAL TILL)
20	24							
	23							
	24							
	118/3"						3	24.3'
		S-6		24.3	100/0"	Drill apparent ROCK		ROCK
25					10/0"*		4	
								26.3' Bottom of Boring
30								

GRANULAR SOILS BLOWS/FT	DENSITY	COHESIVE SOILS BLOWS/FT	DENSITY
0-4	V. LOOSE	<2	V. SOFT
10	LOOSE	2-4	SOFT
30	M DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
>50	V DENSE	15-30	V. STIFF
		>30	HARD

REMARKS: 1) Possible wood encountered at 2'. 2) Obstruction at 7'-8' pulling casing out of plumb, remove 4" casing and continue with 3". 3) Refusal to casing advance encountered at 24'-3"; refusal to split spoon sampler encountered. 4) Drill apparent rock for 24"; very slow advance (30 min. per foot)
* indicates driven using 300 lb. hammer.

GZA

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

BORING No. GZA-5

WELL No. GZA-5
BORING No. GZA-5
FILE No A-2286

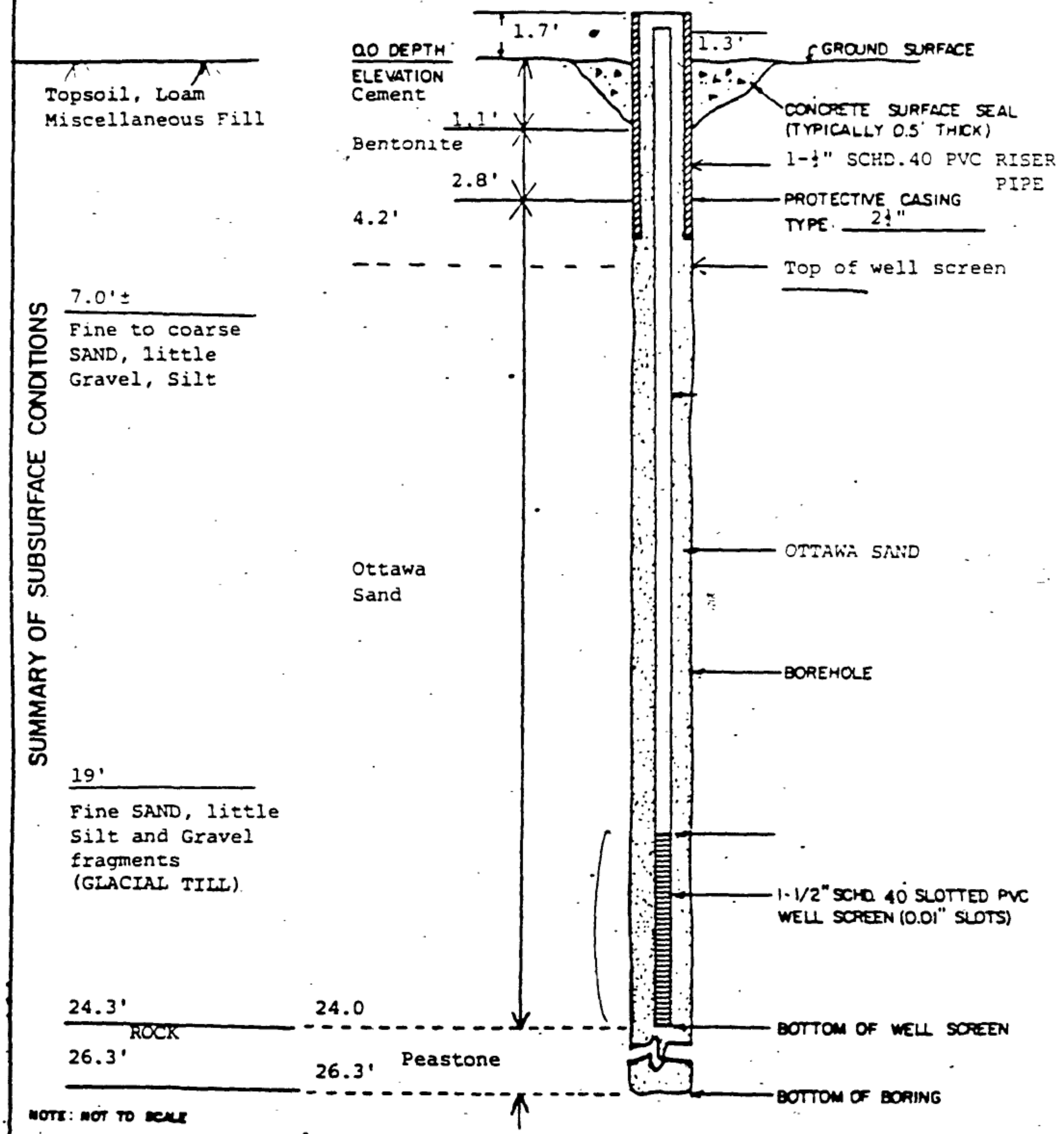
DATE INSTALLED August 23, 1982

PROJECT Wyman Gordon | LOCATION North Grafton, Massachusetts

GZA ENGINEER F. Clark | CONTRACTOR Guild Drilling

WEATHER CONDITIONS Partly Cloudy 70's | DRILLER K. Allen

REMARKS See attached boring log



DEPTH/ELEVATION BOTTOM OF BORING 26.3' / 343.4

DEPTH/ELEVATION BOTTOM OF WELL POINT 24.0' / 345.7

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

WELL No. [illegible]
BORING No
FILE No [illegible]

DATE INSTALLED August 27, 1982

PROJECT Wyman Gordon

LOCATION North Grafton, Massachusetts

GZA ENGINEER Frank Clark

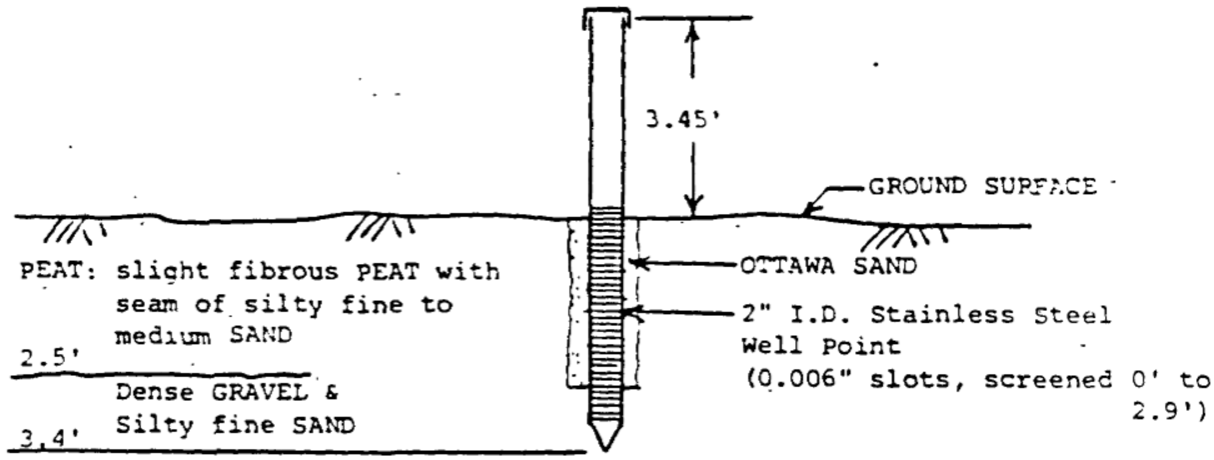
CONTRACTOR —

WEATHER CONDITIONS warm, cloudy

DRILLER (driver well)

REMARKS

SUMMARY OF SUBSURFACE CONDITIONS



NOTE: NOT TO SCALE

DEPTH/ELEVATION BOTTOM OF BORING ______ / ______

DEPTH/ELEVATION BOTTOM OF WELL POINT 3.4' / 362.6

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

GOLDBERG-ZOINO & ASSOCIATES, INC
320 NEEDHAM ST, NEWTON UPPER FALLS, MA
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
WYMAN GORDON
NO. GRAFTON, MASSACHUSETTS

REPORT OF BORING No GZA-6
SHEET 1 OF 1
FILE No A-3288
CHKD BY

BORING Co [illegible]
FOREMAN K. Aller
GZA ENGINEER F. Clark

BORING LOCATION
GROUND SURFACE ELEVATION ______ DATUM ______
DATE START 8/19/82 1100 hours DATE END 8/20/82 [illegible] hours

SAMPLER UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb HAMMER FALLING 30 in.
CASING UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300 lb HAMMER FALLING 24 in
CASING SIZE: 4" (HW) to 9.5' OTHER: 3" (NW) to BOH

GROUNDWATER READINGS

DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
8/23		5.5'	14'	1/2 hour
8/23	0800	5.4'	OW	2 days

DEPTH (ft)	CASING (bl/ft)	SAMPLE No.	PEN/REC (in)	DEPTH (ft)	BLOWS/6"	SAMPLE DESCRIPTION (BURMISTER CLASSIFICATION)	REMARKS	STRATUM DESCRIPTION
		S-1	24/5	0-2	4-5-7-8	Medium dense, brown, loamy SILT, some fine Sand, trace Roots, trace coarse Sand		1'± LOAM
						Cobbles 3' - 5'±		Fine to coarse SAND and GRAVEL, little Silt; occasional cobbles (FILL)
	20							
5	76	S-2	24/8	5-7	6-42-25-51	Very dense, gray-brown, fine to coarse SAND and GRAVEL, little- Silt		
	98							
	75							
	72							
	24	S-3	24/4	9.5-11.5	51-19-17-16	Similar to above		
10	19							
	15							12.0'
	6							
	6							
	7	S-4	24/5	14-16	8-8-6-6	Medium dense, gray, fine to medium SAND, little coarse Gravel, trace Silt		Medium dense, fine to coarse SAND, GRAVEL
15	8							
	10							
	9							
	7							
	11	S-5	24/2	19-21	8-10-6-7	Medium dense, gray, fine to coarse GRAVEL and SAND (poor recovery)		
20	16							
	30							
	105							
	92							
	18	S-6	24/6	24-26	6-10-12-12	Medium dense, gray, fine+ to coarse SAND, some fine to coarse Gravel, trace+ to little- Silt		
25	17							
	35							
	48							28'
	114					Very dense grey fine SAND, some (-) Silt, little fine to coarse Gravel.		Very dense fine SAND, some Silt, trace Gravel
	814	S-7	7/4	29-29.6	85-50*/1	Boulders 29.6 - 31'±		(GLACIAL TILL)
30								
								33.7'
						Drill apparent ROCK		ROCK
								35.7' Bottom of Boring

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	<2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

REMARKS:

1. Drill cobbles and boulders 29.6'-31'±; drill apparent rock from 33.7' - 35.7'.

*indicates driven using 300 lb. hammer.

GZA NOTES 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

BORING No GZA-6

WELL No. GZA-6
BORING No GZA-6
FILE No. A-3288

DATE INSTALLED August 20, 1982

PROJECT Wyman Gordon

LOCATION North Grafton, Massachusetts

GZA ENGINEER F. Clark

CONTRACTOR Guild Drilling

WEATHER CONDITIONS Cloudy, sl. rain

DRILLER K. Allen

REMARKS See attached boring log

SUMMARY OF SUBSURFACE CONDITIONS

1'± LOAM

Dense
Fine to Coarse
SAND & GRAVEL
(FILL)

12'

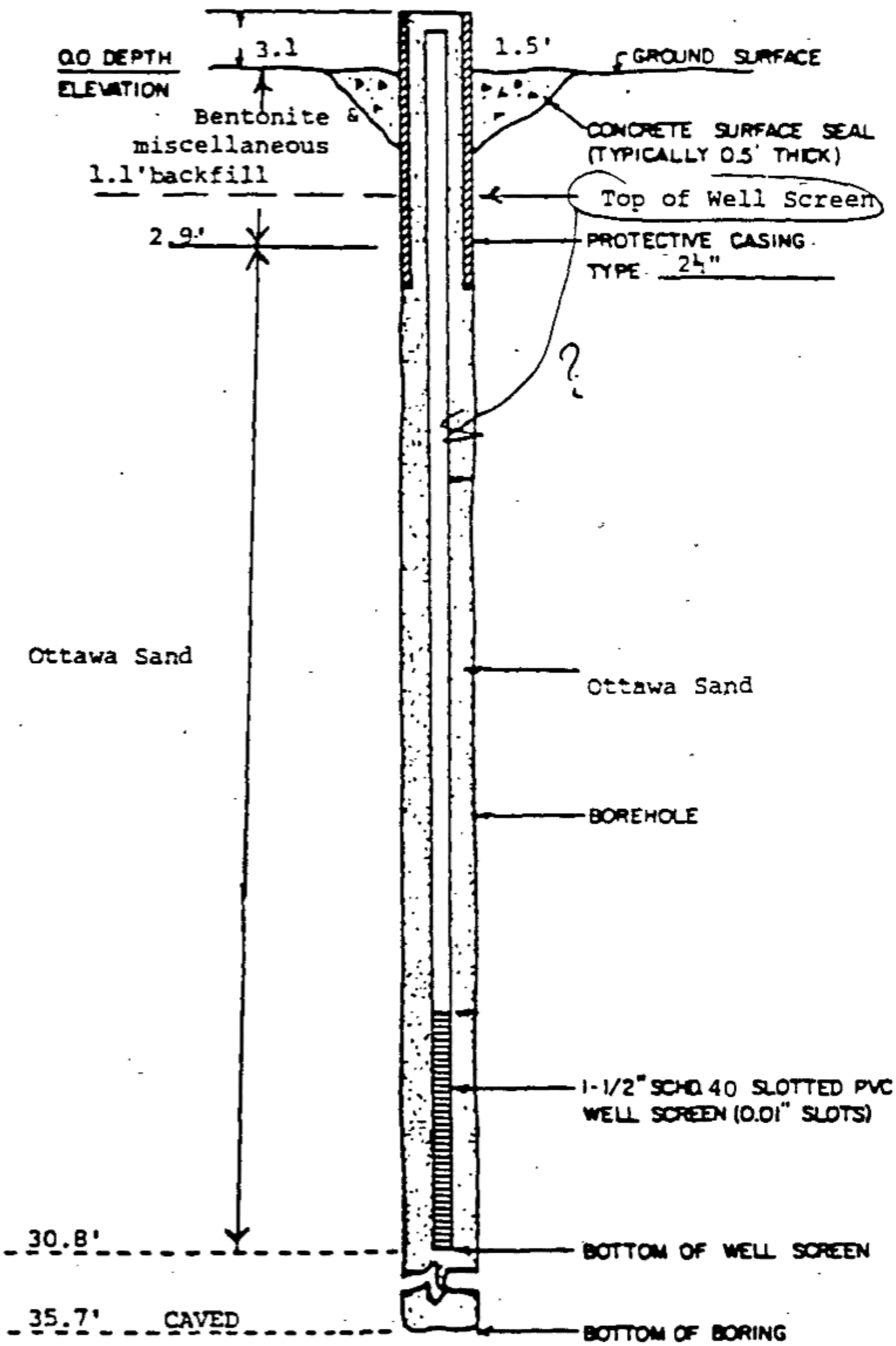
Medium dense
fine to coarse
SAND & GRAVEL

28'

Very dense fine
SAND, some Silt
(GLACIAL TILL)

33.7'

35.7' ROCK



NOTE: NOT TO SCALE

DEPTH/ELEVATION BOTTOM OF BORING 35.7' / 331.9

DEPTH/ELEVATION BOTTOM OF WELL POINT 30.8' / 336.8

GOLDBERG-ZOINO & ASSOCIATES, INC.

WELL No. GZA-6A
BORING No. ______
FILE No A-3286

DATE INSTALLED August 27, 1982

PROJECT Wyman Gordon

LOCATION North Grafton, Massachusetts

GZA ENGINEER Frank Clark

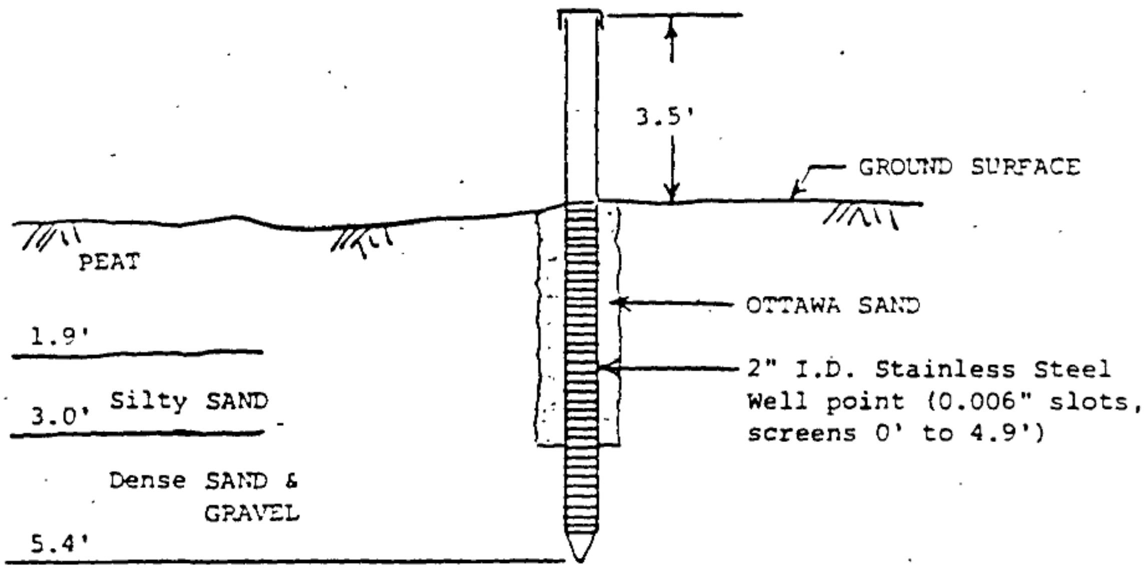
CONTRACTOR —

WEATHER CONDITIONS Warm, cloudy

DRILLER (Driven well)

REMARKS ______

SUMMARY OF SUBSURFACE CONDITIONS



NOTE: NOT TO SCALE

GZA

DEPTH/ELEVATION BOTTOM OF BORING ______ / ______

DEPTH/ELEVATION BOTTOM OF WELL POINT 5.4' / 359.4

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

GOLDBERG-ZOINO & ASSOCIATES, INC.
320 NEEDHAM ST, NEWTON UPPER FALLS, MA
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
WYMAN GORDON
NO. GRAFTON, MASSACHUSETTS

REPORT OF BORING No GZA-7
SHEET 1 OF 1
FILE No A-3289
CHKD BY

BORING Co. Guild Drilling
FOREMAN K. Allen
GZA ENGINEER F. Clark

BORING LOCATION
GROUND SURFACE ELEVATION DATUM
DATE START 8/12/82 DATE END 8 13 82

SAMPLER UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb HAMMER FALLING 30 in
CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300 lb HAMMER FALLING 24 in
CASING SIZE: 4" (HW) to 10' OTHER: 3" (NW) to BOH

GROUNDWATER READINGS

DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
8/13	1400	2.9	5'	1/2 hour
8/19	1230	3.1	OW	6 days

DEPTH (ft)	CASING (bl/ft)	SAMPLE No.	SAMPLE PEN (in)/REC	SAMPLE DEPTH (ft)	SAMPLE BLOWS/6"	SAMPLE DESCRIPTION BURMISTER CLASSIFICATION	REMARKS	STRATUM DESCRIPTION
	--	S-1	24/5	0-2	1-2-5-7	2" dark brown Root Mat		.5' Root Mat, TOPSOIL
	10					3" Loose, brown, loamy, fine to medium SAND		2' Loamy SAND
	25							
	31							
	21							
5	10	S-2	24/2	4.5-6.5	9-6-7-8	Medium dense, gray-brown, fine+ to coarse SAND, little fine Gravel, little− Silt (poor recovery)		Medium dense SAND, little Gravel
	12							
	10							
	9							
	7							
10	5	S-3	24/4	9-11	6-6-6-15	Similar to above	1	10.5'
	7							
	19							
	21					Cobble 14'-4" to 14'-9" 14'-10" to 15'-0"	2 3	Dense SAND, GRAVEL, few Cobbles
	28/8"							
15	20	S-4	24/4	14.5-16.5	15-25	Dense, gray, medium to coarse GRAVEL, some fine+ to medium Sand, little+ Silt		
	12							
	27							
	28							
	18							
20	28	S-5	24/5	19.5-21.5	24-28-26-15	Very dense, gray, fine to coarse SAND, some fine to coarse Gravel, little+ Silt		
	34							
	32							
	33							24'
	21					8" medium dense, gray, fine SAND, little+ Silt		Medium dense, fine SAND, little Silt, trace Gravel
25	--	S-6	24/20	24.5-26.5	23-18-11-14	12" medium dense, brown-gray, fine SAND, little Silt, trace fine to medium Gravel		
	--	6A						
	61							
	65/3"					Cobbles 27'-10" to 30'-4"		
	--						4	
30	--	S-7	18/18	30.5-32.0	10-25-35	Very dense, gray SILT, little fine Sand, slight bedding noted		30.5' Very dense SILT, little fine Sand
		S7A	6/3	32-32.5	65			32.0'±
						Very dense, fine SAND and Rock fragments		32.5' Very dense, fine SAND (TILL) ROCK
								33.7' Bottom of Boring

GRANULAR SOILS BLOWS/FT	GRANULAR SOILS DENSITY	COHESIVE SOILS BLOWS/FT	COHESIVE SOILS DENSITY
0-4	V. LOOSE	<2	V. SOFT
0	LOOSE	2-4	SOFT
		4-8	M. STIFF
-30	M. DENSE	8-15	STIFF
30-50	DENSE	15-30	V. STIFF
>50	V DENSE	>30	HARD

REMARKS: 1. Driller suspects more gravel in stratum and poor recovery due to pushing of gravel pieces. 2. Cobbles encountered between 14'-15'. 3. Sand ran 2' up into casing after washing out to 15'. 4. Cobbles drilled from 27'-10" to 30'-4". 5. Drilled into apparent rock from 32'-6" to 33'-8" rock is extremely hard and advance rate is slow, despite new bit (30 min per foot).

GZA

NOTES. 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

BORING No. GZA-7

GOLDBERG-ZOINO & ASSOCIATES, INC.
320 NEEDHAM ST., NEWTON UPPER FALLS, MA
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
WYMAN GORDON
NO. GRAFTON, MASSACHUSETTS

REPORT OF BORING No. GZA-7
SHEET 1 OF 1
FILE No. A-3289
CHKD BY

BORING Co. Guild Drilling
FOREMAN K. Allen
GZA ENGINEER F. Clark

BORING LOCATION
GROUND SURFACE ELEVATION ______ DATUM
DATE START 8/12/82 DATE END 8/13/82

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb HAMMER FALLING 30 in
CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300 lb HAMMER FALLING 24 in
CASING SIZE: 4" (HW) to 10' OTHER: 3" (NW) to BOH

GROUNDWATER READINGS

DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
8/13	1400	2.9	5'	1/2 hour
8/19	1230	3.1	OW	6 days

DEPTH (ft)	CASING (bl/ft)	SAMPLE No.	PEN (in)/REC	DEPTH (ft)	BLOWS/6"	SAMPLE DESCRIPTION BURMISTER CLASSIFICATION	REMARKS	STRATUM DESCRIPTION
	--	S-1	24/5	0-2	1-2-5-7	2" dark brown Root Mat		.5' Root Mat, TOPSOIL
	10					3" Loose, brown, loamy, fine to medium SAND		2' Loamy SAND
	25							
	31							
	21							
5	10	S-2	24/2	4.5-6.5	9-6-7-8	Medium dense, gray-brown, fine+ to coarse SAND, little fine Gravel, little− Silt (poor recovery)		Medium dense SAND, little Gravel
	12							
	10							
	9							
	7							
10	5	S-3	24/4	9-11	6-6-6-15	Similar to above	1	10.5'
	7							
	19							
	21					Cobble 14'-4" to 14'-9" 14'-10" to 15'-0"	2 3	Dense SAND, GRAVEL, few Cobbles
	28/8"							
15	20	S-4	24/4	14.5-16.5	15-25	Dense, gray, medium to coarse GRAVEL, some fine+ to medium Sand, little+ Silt		
	12							
	27							
	28							
	18							
20	28	S-5	24/5	19.5-21.5	24-28-26-15	Very dense, gray, fine to coarse SAND, some fine to coarse Gravel, little+ Silt		
	34							
	32							
	33							24'
	21					8" medium dense, gray, fine SAND, little+ Silt		Medium dense, fine SAND, little Silt, trace Gravel
25	--	S-6	24/20	24.5-26.5	23-18-11-14	12" medium dense, brown-gray, fine SAND, little Silt, trace fine to medium Gravel		
	--	6A						
	61					Cobbles 27'-10" to 30'-4"		
	65/3"							
	--						4	
30	--	S-7	18/18	30.5-32.0	10-25-35	Very dense, gray SILT, little fine Sand, slight bedding noted		30.5' Very dense SILT, little fine Sand
		S7A	6/3	32-32.5	65			32.0'±
						Very dense, fine SAND and Rock fragments		32.5' Very dense, fine SAND (TILL)
								ROCK
								33.7' Bottom of Boring

GRANULAR SOILS BLOWS/FT	DENSITY	COHESIVE SOILS BLOWS/FT	DENSITY
0-4	V. LOOSE	<2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

REMARKS: 1. Driller suspects more gravel in stratum and poor recovery due to pushing of gravel pieces. 2. Cobbles encountered between 14'-15'. 3. Sand ran 2' up into casing after washing out to 15'. 4. Cobbles drilled from 27'-10" to 30'-4". 5. Drilled into apparent rock from 32'-6" to 33'-8" rock is extremely hard and advance rate is slow, despite new bit (30 min per foot).

GZA

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

BORING No. GZA-7

WELL No. GZA-7
BORING No. GZA-7
FILE No. A-3288

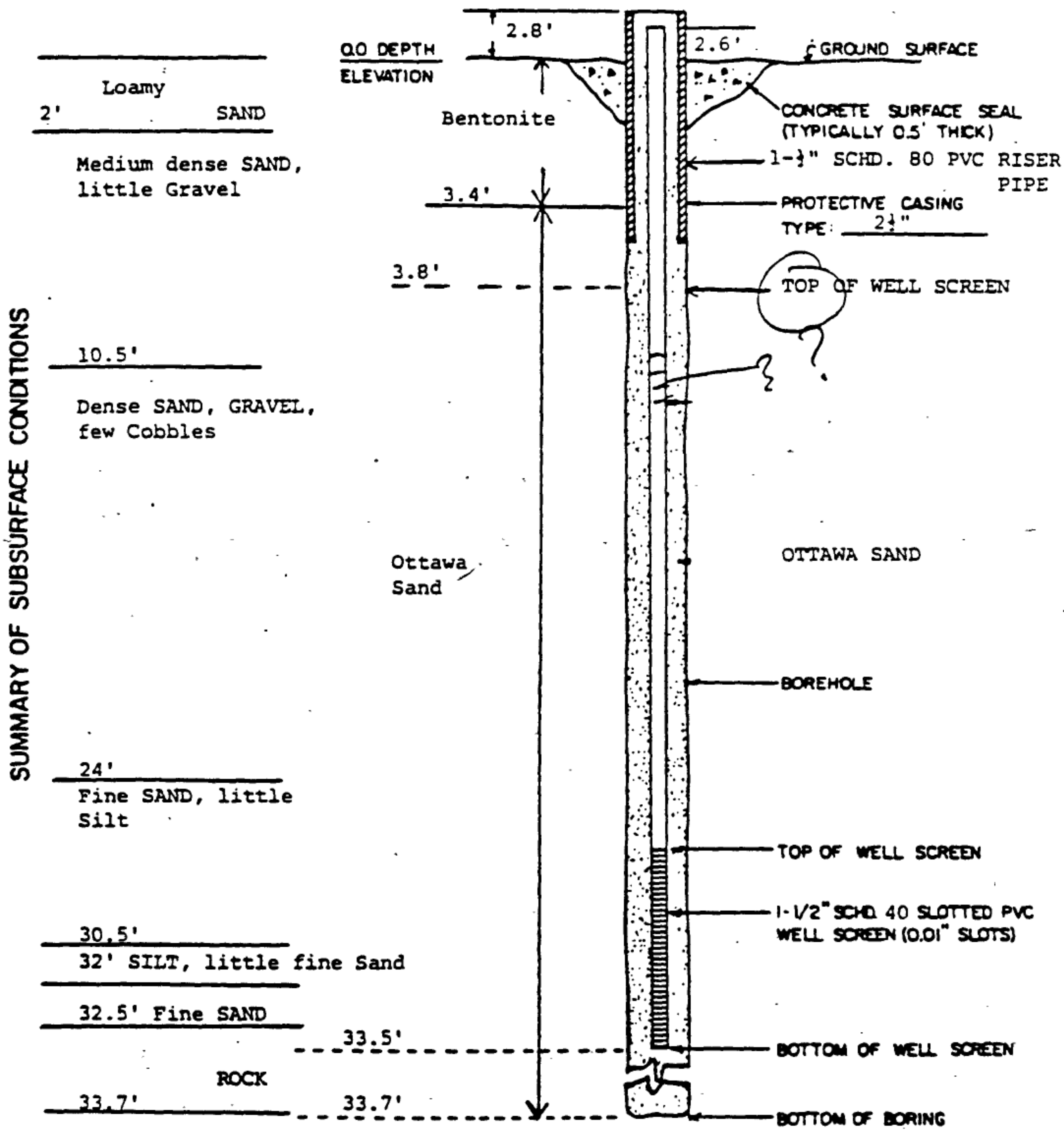
DATE INSTALLED August 23, 1982

PROJECT Wyman Gordon
LOCATION North Grafton, Massachusetts

GZA ENGINEER F. Clark
CONTRACTOR Guild Drilling

WEATHER CONDITIONS Partly Cloudy 70's
DRILLER K. Allen

REMARKS See attached boring log



NOTE: NOT TO SCALE

GZA

DEPTH/ELEVATION BOTTOM OF BORING 33.7' / 327.0
DEPTH/ELEVATION BOTTOM OF WELL POINT 33.5' / 327.2

GOLDBERG-ZOINO & ASSOCIATES, INC.
320 NEEDHAM ST., NEWTON UPPER FALLS, MA
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
WYMAN GORDON
NO. GRAFTON, MASSACHUSETTS

REPORT OF BORING No GZA-8
SHEET 1 OF 2
FILE No A-3288
CHKD BY

BORING Co. Guild Drilling
FOREMAN K. Allen
ZA ENGINEER F. Clark

BORING LOCATION Downgradient 41' s. of drain ditch
GROUND SURFACE ELEVATION ______ DATUM ______
DATE START 8/17/82 1000 hours DATE END 8/18/82

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140lb HAMMER FALLING 30 in

CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300lb HAMMER FALLING 24 in.

CASING SIZE: 4" (HW) to 10' OTHER: 3" (NW) to BOH

GROUNDWATER READINGS

DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
8/18		1.6	24'	1/4 hour
8/19		0.4'	OW	1 day

DEPTH (ft)	CASING (bl/ft)	SAMPLE No.	PEN (in)/REC	DEPTH (ft)	BLOWS/6"	SAMPLE DESCRIPTION BURMISTER CLASSIFICATION	REMARKS	STRATUM DESCRIPTION
		S-1	24/4	0-2	PUSH	Very soft, dark brown, fibrous PEAT, trace Roots		SOFT PEAT
5	20	S-2	12/12	5-6	1-2	Soft, dark brown, fibrous PEAT		6'
	51	2A	12/8	6-7	15-28	Dense, gray, fine+ to medium SAND, little- Silt, trace Gravel		Dense, fine to medium SAND 7.5'±
	44							
	27							
10	7	S-3	24/5	9-11	9-4-5-12	Loose, fine to coarse GRAVEL, some fine+ to coarse Sand, trace Silt		Loose to medium dense, fine to coarse GRAVEL and SAND
	12							
	16							
	23							
	20							
15	7	S-4	24/3	14-16	9-11-12-15	Medium dense, fine+ to coarse SAND, some+ fine to coarse Gravel, little Silt		
	18							
	25							
	30							
	26							19.5'
20	20	S-5	24/12	19-21	8-22-25-41	Dense, fine+ to medium SAND, little fine to medium Gravel, little Silt and Clayey Silt		Dense to very dense, fine to medium SAND, little Gravel and Silt (GLACIAL TILL)
	44							
	51							
	32							
	44							
25	48	S-6	24/18	24-26	32-55-100/2"	Similar to above, very dense, less Gravel in upper 8", fine to coarse Gravel in lower portion		
	54				32/4"*-15*			
	54							
	110							
	40							
30	11	S-7	24/18	29-31	29-42-32	Similar to above, trace Gravel in upper 6", little- some in lower portion of sample		
	9				85			
	45/6"					Cobbles 31.5' to 33'±		31.5' Very dense, fine SAND, some Gravel, Cobbles and Rock fragments
	24							
	45							
35	55							

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT.	DENSITY	BLOWS/FT.	DENSITY
0-4	V. LOOSE	<2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

REMARKS:

1. Apparent refusal to casing at 31.5 feet; drill ahead through cobbles (5" - 6" diameter) and dense gravel from 31.5' to 34'.

*indicates driven using 300 lb. hammer

GZA

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

BORING No. GZA-8

GOLDBERG-ZOINO & ASSOCIATES, INC.
320 NEEDHAM ST., NEWTON UPPER FALLS, MA.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
WYMAN GORDON
NO. GRAFTON, MASSACHUSETTS

REPORT OF BORING No. GZA-8
SHEET 2 OF 2
FILE No. A-3288
CHKD BY

BORING Co. Guild Drilling Company
FOREMAN K. Aller
GZA ENGINEER F. Clark

BORING LOCATION
GROUND SURFACE ELEVATION DATUM
DATE START DATE END

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb HAMMER FALLING 30 in.
CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300 lb. HAMMER FALLING 24 in.
CASING SIZE: OTHER:

GROUNDWATER READINGS

DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME

DEPTH (ft)	CASING (bl/ft)	SAMPLE No.	PEN (in)/REC	SAMPLE DEPTH (ft)	BLOWS/6"	SAMPLE DESCRIPTION BURMISTER CLASSIFICATION	REMARKS	STRATUM DESCRIPTION
35	27	S-8	18/18	34-35.5	90-55*-52*	Very dense, gray, fine SAND, some fine to coarse Gravel and angular rock fragments, little+ Silt		
	39							
	--							
	87							
40	55	S-9	18/12	39.5-41	30.25-41-40½"-20/0"	Cobble 36'-4" to 36'-11" Similar to above		41.5'
							3	ROCK
								42.5' Bottom of Boring
45								

GRANULAR SOILS BLOWS/FT	DENSITY	COHESIVE SOILS BLOWS/FT.	DENSITY
0-4	V. LOOSE	<2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

REMARKS:
2. Drill ahead of casing to advance hole from 34' to bottom of hole.
3. Casing takes up hard at 41.5'; drill apparent rock from 41.5' to to 42.5'; very slow advance (12" in approximately 25 minutes).
* indicates driven using 300 lb. hammer.

GZA NOTES. 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

BORING No. GZA-8

WELL No. GZA-8
BORING No. GZA-8
FILE No. A-3288

DATE INSTALLED August 18-19, 1982

PROJECT Wyman Gordon

LOCATION North Grafton, Massachusetts

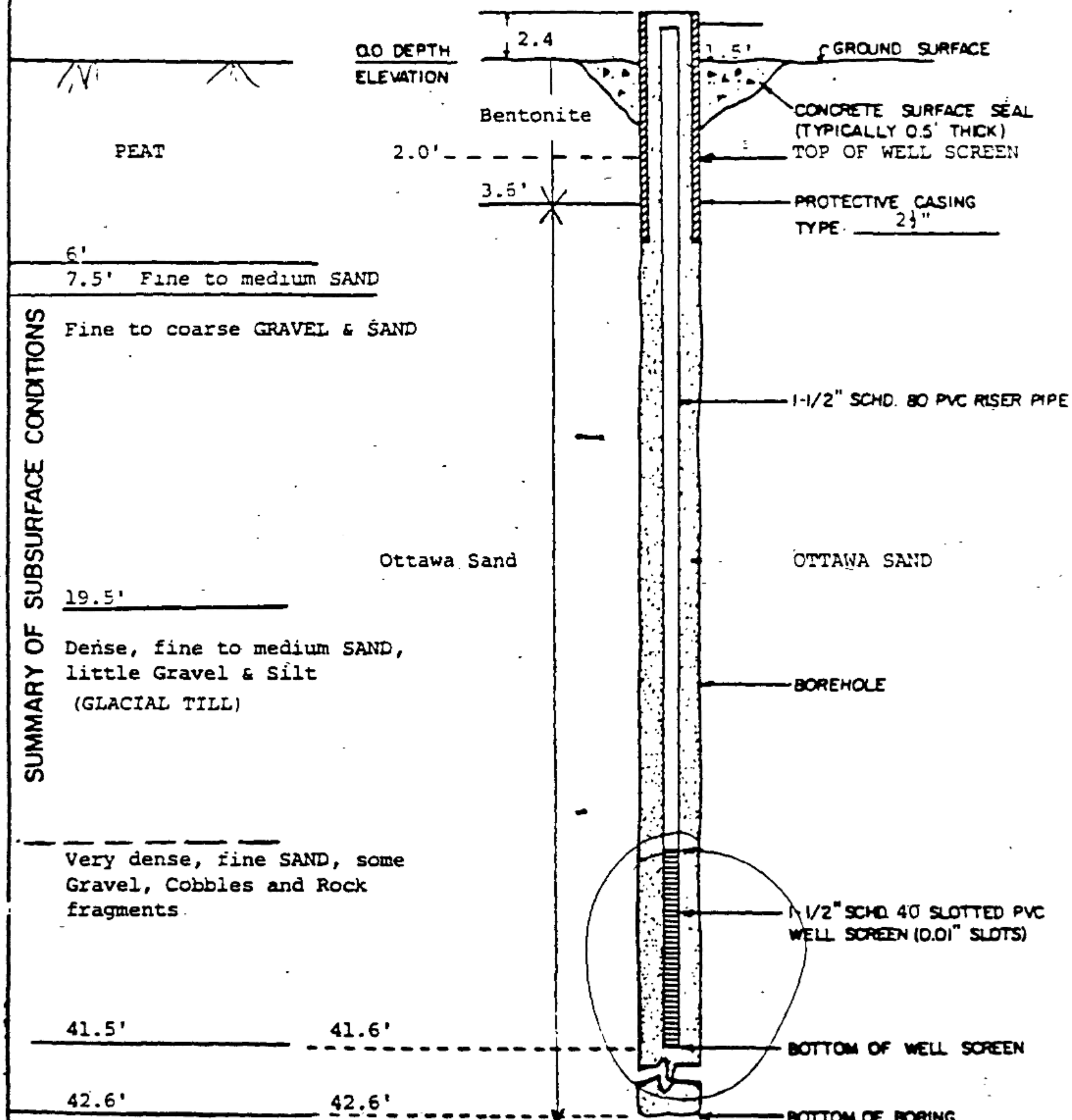
GZA ENGINEER F. Clark

CONTRACTOR Guild Drilling

WEATHER CONDITIONS Partly Cloudy, 70's

DRILLER K. Allen

REMARKS See attached boring log



NOTE: NOT TO SCALE

DEPTH/ELEVATION BOTTOM OF BORING 42.6 / 314.7

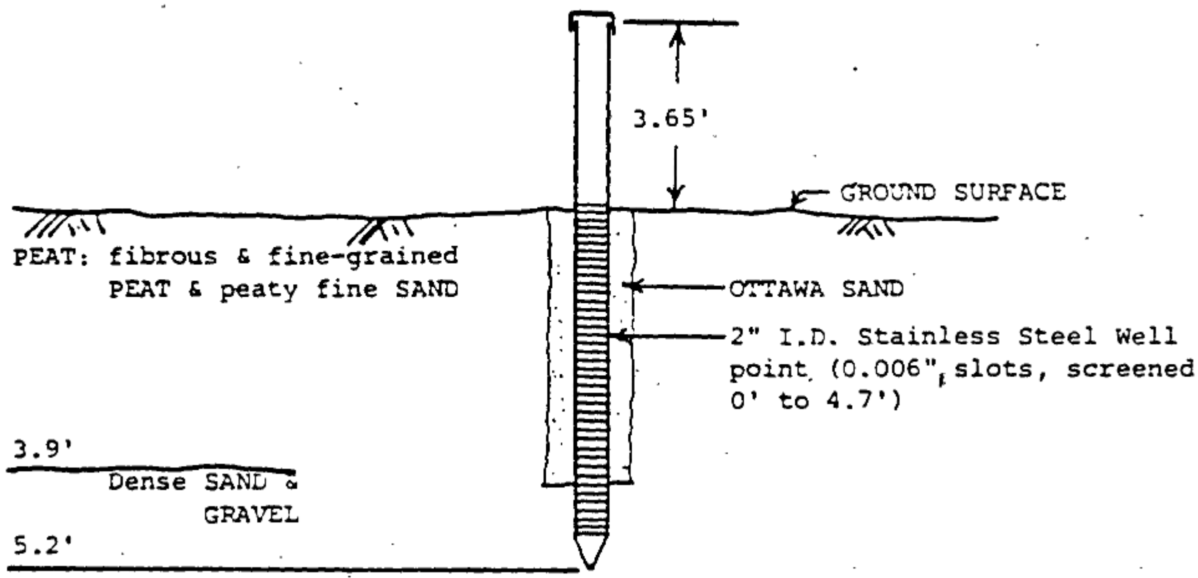
DEPTH/ELEVATION BOTTOM OF WELL POINT 41.6 / 315.7

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

WELL No. GZA-9
BORING No.
FILE No. A-3288

DATE INSTALLED August 27, 1982
PROJECT Wyman Gordon
LOCATION North Grafton, Massachusetts
GZA ENGINEER Frank Clark
CONTRACTOR —
WEATHER CONDITIONS Warm, cloudy
DRILLER (Driven Well)
REMARKS

SUMMARY OF SUBSURFACE CONDITIONS



NOTE: NOT TO SCALE

DEPTH/ELEVATION BOTTOM OF BORING /
DEPTH/ELEVATION BOTTOM OF WELL POINT 5.2' / 352.2

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

GOLDBERG ZOINO & ASSOCIATES, INC
320 NEEDHAM ST., NEWTON UPPER FALLS, MA
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
WYMAN GORDON
NORTH GRAFTON, MASSACHUSETTS

REPORT OF BORING No [illegible]
SHEET [illegible] OF [illegible]
FILE No [illegible]
CHKD BY

BORING Co Guild Drilling Company
FOREMAN [illegible] Whitaker
GZA ENGINEER James Schiff

BORING LOCATION See location plan
GROUND SURFACE ELEVATION ______ DATUM ______
DATE START 6/18/84 DATE END [illegible]

SAMPLER UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140lb HAMMER FALLING 30 in
CASING UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300lb HAMMER FALLING 24 in
CASING SIZE [illegible] OTHER:

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
6/18/84	1500	[illegible]	out	[illegible]

DEPTH (ft)	CASING (bl/ft)	SAMPLE No	PEN (in)/REC	SAMPLE DEPTH (ft)	BLOWS/6"	SAMPLE DESCRIPTION — Burmister CLASSIFICATION	REMARKS	STRATUM DESCRIPTION
	4	S-1	24/8	0-1	2-9	Medium dense, brown Silty TOPSOIL, little roots, trace fine Sand, changing to a dense brown coarse to fine GRAVEL, some fine to medium Sand, trace (-) Silt		1.0 TOPSOIL
	10	S-1A	/12	1-2	20-45			
	70							
	52							GRANULAR FILL
	12	S-2	24/10	4-6	24-9-8-5	Medium dense, brown coarse to fine SAND, little medium to coarse Gravel, trace (+) Silt		
5	14							
	9							
	45							
	54							9.5
10	86	S-3	24/10	9-11	65-5-6-8	Medium dense, brown SILT, and Peat, little fine to medium Sand, trace (-) Gravel		SILT AND PEAT
	54							11.5 ±
	54							
	48							
	54							
15	13	S-4	24/12	14-16	17-19-8-10	Medium dense, brown coarse to fine SAND, some medium to coarse Gravel, trace (-) Silt		SAND
	11							
	16							
	21							
	24							
20	8	S-5	24/4	19-21	8-6-10-17	Medium dense, brown coarse to fine SAND, little medium to coarse Gravel, trace (-) Silt		
	27							
	25							
	20							
	23							24.0 ±
25	31	S-6	24/8	24-26	20-17-7-9	Medium dense, brown fine to coarse SAND, some Silt, trace (-) Gravel		
	30							
	36							
	47							
	103							
30	28	S-7	6/5	29-29.5	103/6	Very dense, gray medium to fine SAND, little Silt, trace Gravel, trace cobbles		GLACIAL TILL
	10							
	11							
	11							
	46							
35	51	S-8	24/12	34-36	48-55-35-36	Very dense, gray medium to fine SAND, little Silt, trace Gravel, trace cobbles		

GRANULAR SOILS BLOWS/FT	DENSITY	COHESIVE SOILS BLOWS/FT	DENSITY
0-4	V LOOSE	< 2	V SOFT
4-10	LOOSE	2-4	SOFT
10-30	M DENSE	4-8	M STIFF
30-50	DENSE	8-15	STIFF
50	V DENSE	15-30	V STIFF
		>30	HARD

REMARKS

1. Washed ahead with roller bit from 29 to 34 feet prior to driving casing.

GZA NOTES 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

BORING No. GZA-10

GOLDBERG Z[illegible]
320 NEEDHAM ST, NEWTON UPPER FALLS, MA
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
WYMAN GORDON
NORTH GRAFTON, MASSACHUSETTS

REPORT OF BORING No [illegible]
SHEET ___ OF ___
FILE No F-4232
CHKD BY ___

DEPTH (ft)	CASING (bl/ft)	SAMPLE No	PEN (in)/REC	DEPTH (ft)	BLOWS/6"	SAMPLE DESCRIPTION Burmister CLASSIFICATION	REMARKS	STRATUM DESCRIPTION
	72							
	77							
	84							GLACIAL TILL
	131	S-9	3/10	39-39.3	100/3	No Recovery		
40		C-1	6/0	39.3-40	8 min/.7 ft	Cored rock no recovery		40.0'
						Refusal at 40.0 feet		
45								
50								

REMARKS:

GZA

BORING No. GZA-10

WELL No. GZA-1C
BORING No. GZA-1C
FILE No. F-4232

DATE INSTALLED June 18, 1984
PROJECT Wyman Gordon
LOCATION North Grafton, Massachusetts
GZA ENGINEER James Schiff
CONTRACTOR Guild Drilling
WEATHER CONDITIONS Sunny 80°
DRILLER Al Whitaker
REMARKS

SUMMARY OF SUBSURFACE CONDITIONS

0.0 DEPTH
ELEVATION

1.0'Topsoil

Brown coarse to fine
SAND, little Gravel (Granular Fill)

9.5'
Silt and Peat

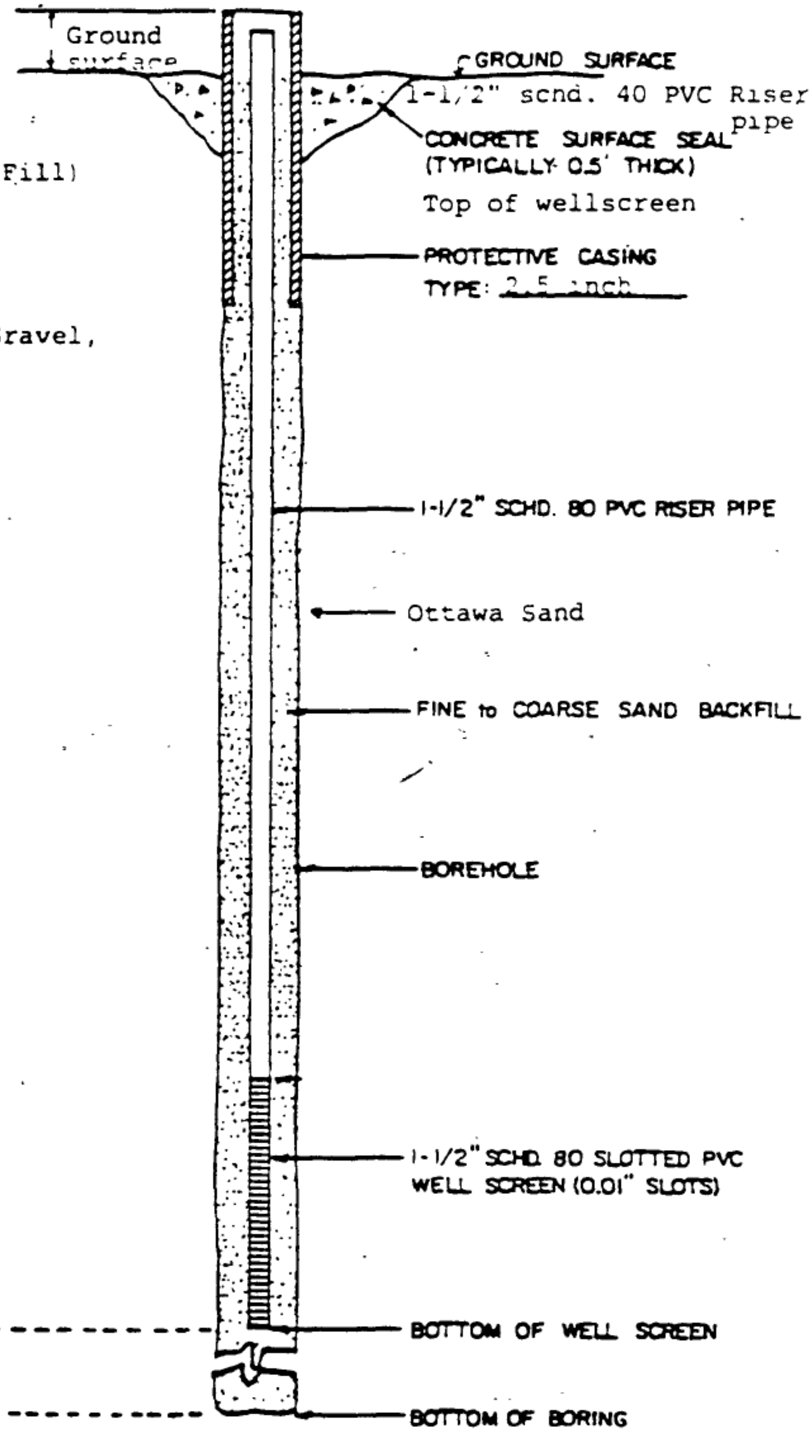
11.5'
Coarse to fine SAND, some Gravel,
trace Silt

24.0' ±

Medium to fine SAND, little
to some Silt, trace Gravel
(Glacial Till)

34.0 feet

40.0'



NOTE: NOT TO SCALE

DEPTH/ELEVATION BOTTOM OF BORING 40 ft. / 334.6
DEPTH/ELEVATION BOTTOM OF WELL POINT 34 ft. / 340.6

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS

[redacted]

GOLDBERG-ZOINO & ASSOCIATES, INC
320 NEEDHAM ST., NEWTON UPPER FALLS, MA
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
Wyman & Gordon
Grafton, Mass.

REPORT OF BORING No. [illegible]
SHEET [illegible] OF [illegible]
FILE No. [illegible]-4232
CHKD BY

BORING Co. [illegible] Drilling Co
FOREMAN John Halabuta
ENGINEER James Schiff

BORING LOCATION See Location Plan
GROUND SURFACE ELEVATION DATUM
DATE START [illegible]
DATE END [illegible]/84

SAMPLER UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb HAMMER FALLING 30 in.

CASING UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300 lb HAMMER FALLING 24 in

CASING SIZE 3 inch I.D. OTHER:

GROUNDWATER READINGS

DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
[illegible]-84	[illegible]	Gnd	Removed	Completion

DEPTH (ft)	CASING (bl/ft)	SAMPLE No.	PEN (in)/REC	DEPTH (ft)	BLOWS/6"	SAMPLE DESCRIPTION Burmister CLASSIFICATION	REMARKS	STRATUM DESCRIPTION
		S1	24/10	0-2'	1/12"-3-4	Very loose brown fine SAND & SILT, trace roots, trace Peat.		Fine SAND & SILT Swamp Marsh 3±
5		S2	24/18	5-7	24-50-45-45	Very dense gray coarse to fine SAND, some coarse to fine Gravel, trace (-) Silt.		Coarse to Fine SAND, some Gravel with Cobble & Boulders, trace Silt
10		S3	24/20	10-12	20-15-15-70	Medium dense gray coarse to fine SAND, little Silt, trace Gravel, pushed Cobble at 11.5 ft.	1	
15		S4	24/10	15-17	45-36-25-46	Very dense gray coarse to find SAND, some Silt, trace (-) Gravel, Cobble and Boulders.		
20		S5	10"/6"	20"-20-10"	43-150/4"	Very dense coarse to fine SAND, some Silt, little (+) medium to coarse Gravel, Cobble lodged in nose of spoon.		23±
								Glacial Till
25		S6	6"/4"	25-25'6"	230/6"	Very dense gray coarse to fine SAND, some Silt, little coarse Gravel, Cobble or Weather Rock in split spoon.	2	25.5
						Bottom of Boring at 25.5 ft.		

GRANULAR SOILS BLOWS/FT	DENSITY	COHESIVE SOILS BLOWS/FT	DENSITY
0-4	V. LOOSE	<2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
[illegible]	DENSE	8-15	STIFF
[illegible]	V. DENSE	15-30	V. STIFF
		>30	HARD

REMARKS:

1. Very difficult driving casing - encountered Cobbles and Boulder from 11.5 to 25 ft. Bottom 5. ft. of casing (20 to 25 ft.) slightly bent do to driving casing
2. Installed observation well at 25.3 ft. - See installation log.

GZA

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

BORING No. GZA-11

WELL No GZA-11
BORING No GZA-11
FILE No F-4232.0

DATE INSTALLED 8/2/84

PROJECT Wyman & Gordon

LOCATION Grafton Massachusetts

GZA ENGINEER James Schiff/psr

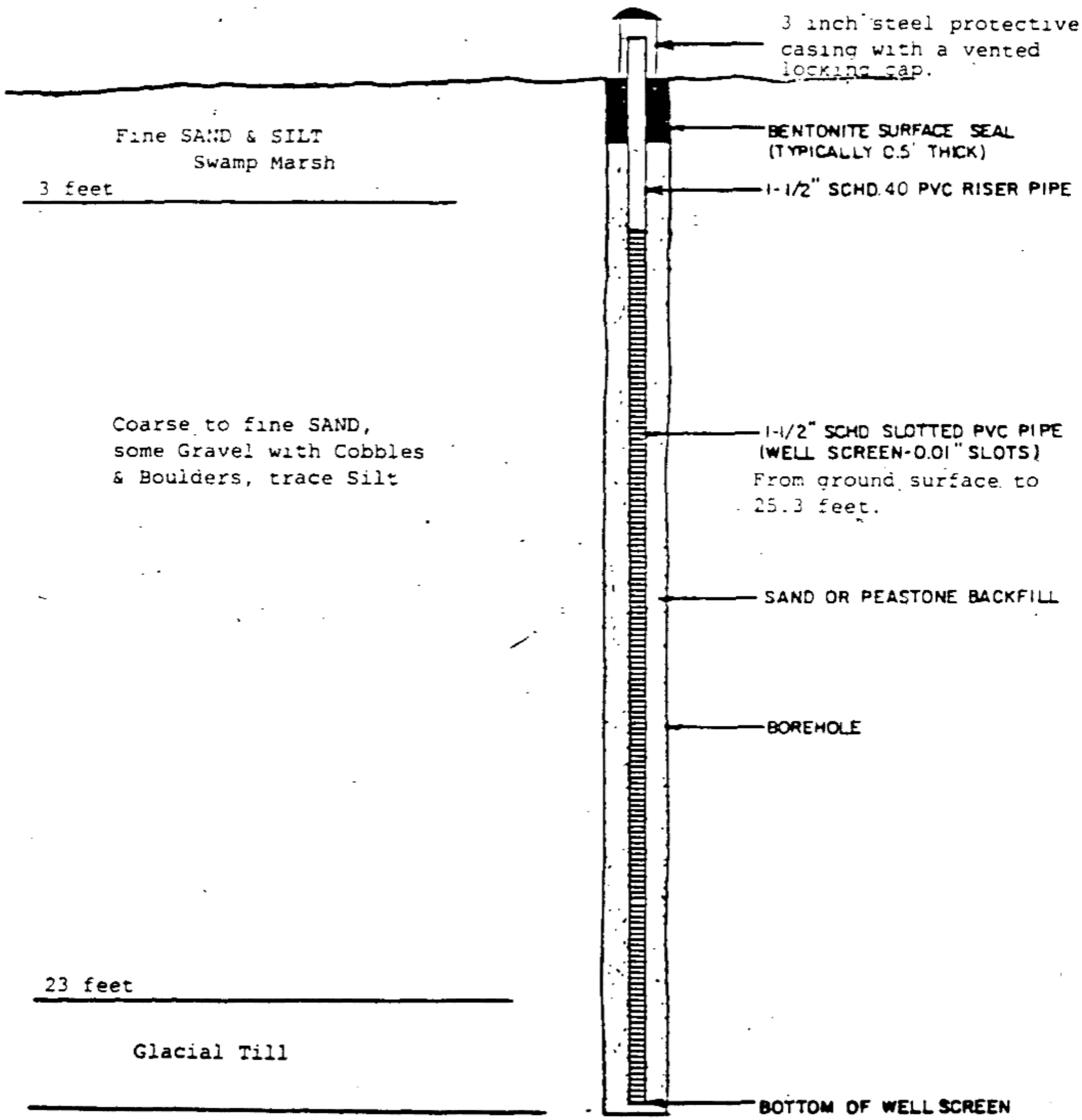
CONTRACTOR Guild Drilling Company

WEATHER CONDITIONS Sunny 70^{o}-80^{o}

DRILLER John Halaputa

REMARKS See boring log for soil description

SUMMARY OF SUBSURFACE CONDITIONS



Bottom of boring at 25.5 feet.

TE NOT TO SCALE

DEPTH/ELEVATION BOTTOM OF BORING 25.5ft./ ____

DEPTH/ELEVATION BOTTOM OF WELL POINT 25.3ft./ ____

GZA

GOLDBERG-ZOINO & ASSOCIATES, INC.

GOLDBERG-ZOINO & ASSOCIATES, INC. 320 NEEDHAM ST., NEWTON UPPER FALLS, MA GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT Wyman & Gordon Grafton, Mass	REPORT OF BORING No. [illegible] SHEET [illegible] OF [illegible] FILE No. [illegible]-423[illegible] CHKD BY

BORING Co. [illegible] Drilling Co.
FOREMAN John [illegible]
GZA ENGINEER James Schiff
BORING LOCATION See Location Plan
GROUND SURFACE ELEVATION ______ DATUM ______
DATE START [illegible]/84 DATE END [illegible]/84

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140lb HAMMER FALLING 30 in
CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300lb HAMMER FALLING 24 in
CASING SIZE 3 inch I.D. OTHER:

GROUNDWATER READINGS

DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
[illegible]/84	1400	Gnd	Removed	Completion

DEPTH (ft)	CASING (bl/ft)	SAMPLE No.	PEN (in) / REC	DEPTH (ft)	BLOWS/6"	SAMPLE DESCRIPTION Burmister CLASSIFICATION	REMARKS	STRATUM DESCRIPTION
		S1	24/6"	0-2	Pushed Rods	Very soft fine SAND & SILT, trace Root, trace Peat		FINE SAND & SILT SWAMP MARSH 3'
5		S2	24/10"	5'-7'	26-29-135-45	Very dense gray medium to fine SAND, some Silt, little coarse to fine Gravel with Cobbles		MEDIUM TO FINE SAND, SOME SILT
10		S3	12"/6"	10-11	60-150	Very dense brown medium to fine SAND, some Silt, little coarse to fine Gravel, Cobbles and Boulders	1	MEDIUM TO FINE SAND, SOME SILT, COBBLES AND BOULDERS
		C1	12"/8"	12.5-13.5	—	Cored BOULDER		
		S4	9"/6"	13.5-14.3	31*-43/3"*	Same soil description as Sample S3	2	
15							5	
			3"/-	15-15.3'	200/3"	Refusal with Open End A-ROD	3	
		C2	5'/15"	15.3-20.3	8 min/ft	Cored BOULDERS AND COBBLE, very dense unable to drive Casing through Boulders		
					4 min/ft			
					1 min/ft			
					1 min/ft			
20		S5	24/12"	20.3-22.3	15-15-65-96	Very dense brown medium to fine SAND, some Silt, Cobbles and Boulders	4	
						Bottom of boring at 22.3 ft.		
25								
30								

GRANULAR SOILS BLOWS/FT	DENSITY	COHESIVE SOILS BLOWS/FT	DENSITY
0-4	V. LOOSE	<2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
>50	V. DENSE	15-30	V. STIFF
		>30	HARD

REMARKS:

1. Drove Casing to 12.5 ft. Refusal with Casing and Wash Bit
   * Indicates 300 lb. Hammer to Drive Split Spoon
2. Drove Casing to 15 ft., Encountered Boulders and Cobbles Refusal at 15 ft. with Open-End A Rod
3. Cored from 15.3 to 20.3 ft., Very Dense Cobbles and Boulders
4. Hole Collapse to 15 ft., Bottom of Casing
5. Installed observation well at 15 ft. - seet installation log.

GZA NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

BORING No. GZA-1[illegible]

WELL No. GZA-12

BORING No. GZA-12

FILE No. F-4[illegible]

DATE INSTALLED 8/3/84

PROJECT Wyman & Gordon

LOCATION Grafton, Massachusetts

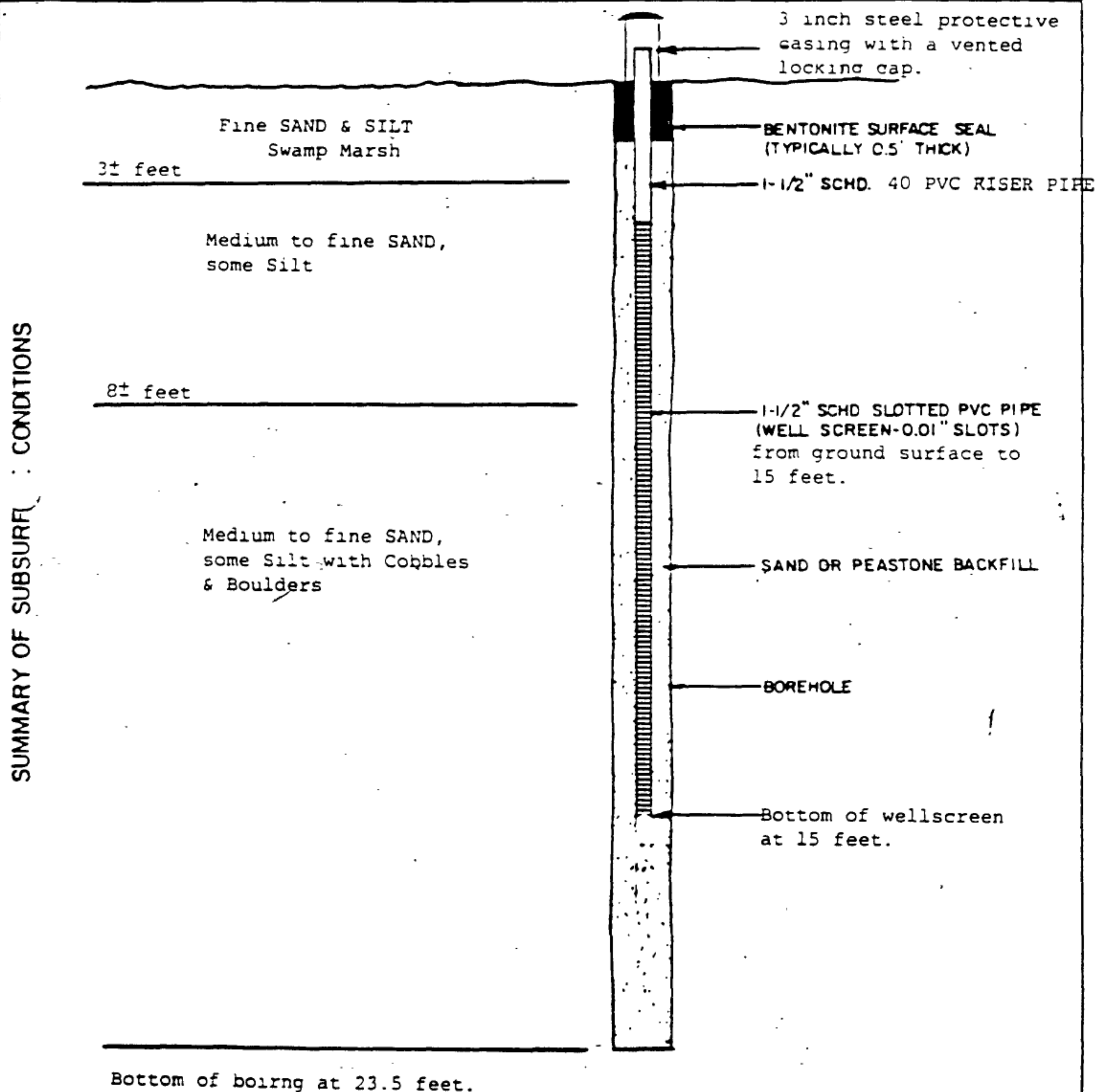
GZA ENGINEER James Schiff/psr

CONTRACTOR Guild Drilling Company

WEATHER CONDITIONS Sunny 70°-80°

DRILLER John Halabuta

REMARKS See boring log for soil description



NOTE: NOT TO SCALE

GZA

DEPTH/ELEVATION BOTTOM OF BORING 22.5ft. /

DEPTH/ELEVATION BOTTOM OF WELL POINT 15ft. /

STICK UP OF WELL 2.6 ft.

GOLDBERG-ZOINO & ASSOCIATES INC.

APPENDIX D

DECONTAMINATION PROCEDURES USED BY HWGWTF CONTRACTOR

Decontamination Procedures

- Submersible pump and associated tubing, ropes and wire - cleaned after each use with a non-phosphate soap and rinsed with tap water

- Bladder pumps - pre-cleaned pumps will be used on each well; none will be cleaned or reused during the inspection

- Interface probe - cleaned after each use with a pesticide grade hexane wipe, followed by a rinse with distilled water and wiped dry

- Filtering apparatus - cleaned with 1:1 nitric acid diluted with distilled water, then rinsed with distilled water

APPENDIX E

GROUND-WATER SAMPLING RESULTS TAKEN BY WYMAN-GORDON COMPANY

TABLE 1

SUMMARY OF WELL SURFACE AND WATER SAMPLING

GZA WELLS	DESCRIPTION	7/13/82	9/27/82	11/15/83	3/23/84	6/12/84 - 7/2/84	6/29/84	7/2/84	8/28/84	10/10/84	10/19/84
GZA-1	RCRA wells	✓	✓								
GZA-2		✓	✓								
GZA-3		✓	✓								
GZA-4		✓	✓								
GZA-5	Hydrogeologic Assessment		✓								
GZA-5A*			✓								
GZA-6			✓								
GZA-6A*			✓		✓		✓		✓		
GZA-7			✓								
GZA-8			✓								
GZA-9*			✓								
GZA-10	Supplemental wells										
GZA-11								✓			
GZA-12											

<u>Surface Stations</u>

		7/13/82	9/27/82	11/15/83	3/23/84	6/12/84 - 7/2/84	6/29/84	7/2/84	8/28/84	10/10/84	10/19/84
EB-1	East Brook downstream					✓			✓	✓	
EB-2	East Brook upstream					✓			✓	✓	
SPE-3	East Brook at Hovey Pond			✓							
SPE-4	Quinsigamond River			✓							

<u>Off-Site Wells</u>

		7/13/82	9/27/82	11/15/83	3/23/84	6/12/84 - 7/2/84	6/29/84	7/2/84	8/28/84	10/10/84	10/19/84
14 DL	Well at 14 Donahue Lane										✓
22 DL	Well at 22 Donahue Lane										✓

<u>NOTES</u>:

1. All GZA wells screened in upper aquifer except * which are hand-dirven to steel wellscreens at depths of 3.4 to 5.4 feet.

2. Surface stations grab sampled; see plan for locations.

3. Details of private supply wells on Donahue Lane not known.

TABLE 2

ANALYTICAL PARAMETERS INDICATIVE OF
LAGOON INFLUENCE

Arsenic
Fluoride
Nitrate
Sodium
Sulfate
Nickel
pH
Specific conductance

NOTE:

1. Above perameters were considered to be indicative of influence from the Rinsewater Facility Lagoons based upon analytical data provided by Wyman Gordon Company and from initial sampling of GZA monitoring wells.

TABLE 3

SUMMARY OF CHEMICAL ANALYSES - RCRA WELLS

JULY 13, 1982

	GZA-1	GZA-2	GZA-3	GZA-4
I. RCRA PARAMETERS				
1. Drinking Water Supply Parameters				
Arsenic (μg/l)	<5	<5	100	<5
Barium (μg/l)	<200	<200	<200	<200
Cadmium (μg/l)	<1	<1	<1	<1
Chromium (μg/l)	<5	<5	15	<5
Fluoride (mg/l)	3.6	37	62	6.2
Lead (μg/l)	6	<5	<5	<5
Mercury (μg/l)	<0.2	<0.2	<0.2	<0.2
Nitrate (as N) (mg/l)	9.5	23	24	26
Selenium (μg/l)	<5	<5	<5	<5
Silver (μg/l)	<1	<1	<1	<1
2,4-D (μg/l)(3)	ND	ND	ND	ND
Combined Radium (pCi/l)	--	--	--	--
Radium 226	1.0±0.2	1.7±0.2	2.3±0.2	3.9±0.3
Gross Alpha (pCi/l)	4±2	14±7	5±6	4±5
Gross Beta (pCi/l)	10±3	39±11	23±10	6±9
Coliform Bacteria (colonies/100 ml)	<2	16	Sample broken	16
2. Groundwater Quality Parameters				
Chloride (mg/l)	105	105	109	88
Iron (mg/l)	<0.05	0.29	0.21	0.36
Manganese (mg/l)	0.07	0.17	<0.05	0.72
Phenol (mg/l)	<0.01	0.03	0.02	<0.01
Sodium (mg/l)	83	500	520	380
Sulfate (mg/l)	19	390	330	320
3. Groundwater Contamination Parameters				
Total Organic Carbon (mg/l)	11;9;8;8	51	18	20
Total Organic Halogen (mg/l) (mg/l)	<0.02;<0.02; <0.02;<0.02	0.15	0.10	0.05
pH	5.9;5.8 6.1;6.2	6.8	9.6	6.5
Specific Conductance (μmhos/cm at 25°C)	500;390; 470;490	1470	1860	1400

TABLE 3a SUMMARY OF CHEMICAL ANALYSES (cont'd)

A. JULY 13, 1982 (cont'd)

	GZA-1	GZA-2	GZA-3	GZA-4
II. OTHER INORGANICS				
Nickel (µg/l)	--	--	--	--
Turbidity (NTU)	1	60	39	49
III. PESTICIDES AND HERBICIDES (3)				
Endrin (µg/l)	ND	ND	ND	ND
Lindane (µg/l)	ND	ND	ND	ND
Methoxychlor (µg/l)	ND	ND	ND	ND
Toxaphene (µg/l)	ND	ND	ND	ND
Silvex (µg/l)	ND	ND	ND	ND

TABLE 4 SUMMARY OF CHEMICAL ANALYSES GZA-5 through GZA-9

SEPTEMBER 27-28, 1982

	GZA-5	GZA-5A	GZA-1	GZA-2	GZA-3	GZA-4
I. RCRA PARAMETERS						
1. Drinking Water Supply Parameters						
Arsenic (µg/l)	<5	<5	11	23	69	52
Barium (µg/l)	--	--	<200	<200	<200	<200
Cadmium (µg/l)	--	--	<1	<1	<1	<1
Chromium (µg/l)	<5	<5	<5	<5	7	<5
Fluoride (mg/l)	0.12	<0.10	18	28	56	18
Lead (µg/l)	--	--	<5	<5	<5	<5
Mercury (µg/l)	--	--	<0.2	<0.2	<0.2	<0.2
Nitrate (as N)(mg/l)	7.2	<0.05	37	34	45	34
Selenium (µg/l)	--	--	<10	<10	<10	<10
Silver (µg/l)	--	--	<1	<1	<1	<1
2,4-D (µg/l)(3)	--	--	ND	ND	ND	ND
Combined Radium (pCi/l)	--	--	5.8±0.5	2.6±0.7	0.65±0.6	9.9±2.0
Radium 226	--	--	1.2±0.2	1.1±0.2	0.25±0.09	3.9±0.3
Gross Alpha (pCi/l)	--	--	8±6	11±10	-5±7	19±8
Gross Beta (pCi/l)	--	--	30±13	20±20	20±30	45±14
Coliform Bacteria (colonies/100 ml)	--	--	10	20	<10	<10
2. Groundwater Quality Parameters						
Chloride (mg/l)	--	--	120	120	130	110
Iron (mg/l)	--	--	0.025	0.860	0.038	0.31
Manganese (mg/l)	--	--	0.052	0.170	<0.020	0.20
Phenol (mg/l)	--	--	0.014	0.011	0.017	<0.01
Sodium (mg/l)	49	100	460	735	640	450
Sulfate (mg/l)	39	31	400	920	560	380
3. Groundwater Contamination Parameters						
Total Organic Carbon (mg/l)	--	--	26;10; 20;27	34	34	35
Total Organic Halogen (mg/l)	0.027	0.024	0.30;0.26; 0.30;0.28	0.11	0.052	0.03
pH	6.6	6.2	6.7;6.7; 6.7;6.7	7.0	9.8	7.1
Specific Conductance (µmhos/cm at 25°C)	446	711	1970; 1940; 1970; 1980	2820	2470	1810
II. OTHER INORGANICS						
Nickel (µg/l)	<10	32	57	17	<10	330
Turbidity			<1	70	40	60

TABLE 4a SUMMARY OF CHEMICAL ANALYSES GZA-5 THROUGH GZA-9 (cont'd)

SEPTEMBER 27-28, 1982 (cont'd)

	GZA-6	GZA-6A	GZA-7	GZA-8	GZA-9	SURFACE WATER EB-1	EB-2
I. RCRA PARAMETERS							
1. Drinking Water Supply Parameters							
Arsenic (µg/l)	2100	770	8	<5	<5	140	<5
Barium (µg/l)	--	--	--	--	--	--	--
Cadmium (µg/l)	--	--	--	--	--	--	--
Chromium (µg/l)	<50(1)	<50(1)	<5	<5	<5	<5	<5
Fluoride (mg/l)	24	51	6.6	3.0	0.18	13	<0.10
Lead (µg/l)	--	--	--	--	--	--	--
Mercury (µg/l)	--	--	--	--	--	--	--
Nitrate (asN)(mg/l)	22	38	25	19	1.7	6.7	0.76
Selenium (µg/l)	--	--	--	--	--	--	--
Silver (µg/l)	--	--	--	--	--	--	--
2,4-D (µg/l)	--	--	--	--	--	--	--
Combined Radium (pCi/l)	--	--	--	--	--	--	--
Gross Alpha (pCi/l)	--	--	--	--	--	--	--
Gross Beta (pCi/l)	--	--	--	--	--	--	--
Coliform Bacteria (colonies/100 ml)	--	--	--	--	--	--	--
2. Groundwater Quality Parameters							
Chloride (mg/l)	--	--	--	--	--	--	--
Iron (mg/l)	--	--	--	--	--	--	--
Manganese (mg/l)	--	--	--	--	--	--	--
Phenol (mg/l)	--	--	--	--	--	--	--
Sodium (mg/l)	880	780	220	160	110	180	33
Sulfate (mg/l)	1600	1100	410	230	150	170	84
3. Groundwater Contamination Parameters							
Total Organic Carbon (mg/l)	--	--	--	--	--	--	--
Total Organic Halogen (mg/l)	0.11	0.32	0.097	0.068	0.30	0.039	0.026
pH	11.1	7.1	6.7	6.8	6.4	8.9	6.6
Specific Conductance (µmhos/cm at 25°C)	3140	2120	1042	720	757	880	282
II. OTHER INORGANICS							
Nickel (µg/l)	<100(1)	<100(1)	<100(1)	<10	30	<10	<10

NOTES:
1. Dectection limits are elevated due to severe matrix interferences.
2. All readings are by ERCO except pH and conductivity data for phase II wells, which were measured by GZA.
3. Detection limit 0.1 µg/l.
4. -- indicates not analyzed.
5. ND = not detected.

TABLE 6

SUMMARY OF CHEMICAL ANALYSES
GZA-6 QUARTERLY MONITORING

PARAMETER (mg/l)	3/23/84	6/29/84	8/28/84
Arsenic	.200	.210	.700
Cadmium	--	.00069	.00091
Chromium	.028	.072	.022
Nickel	.011	.015	<.005
Cyanide	.012	.030	<.010
pH	10.6	9.2	10.9
Conductivity (mhos/cm)	1856	2400	3500

NOTE:

1. Samples recovered by GZA on the dates indicated and analyzed by ERCO except pH and conductivity (GZA measured in field) and 8/28 cyanide data (analyzed by Metcalf & Eddy of Boston, Massachusetts).

TABLE 8

SUMMARY OF ANALYTICAL RESULTS
WELLS GZA-10, GZA-11, GZA-12

WELL	GZA-10	GZA-11			GZA-12		
DATE SAMPLED	7/24/84	8/28/84	10/10/84		8/28/84	10/10/84	
Water Elevation	364.9	361.0	360.6		357.7	357.3	
pH	6.7	8.35	6.6		7.4	6.25	
Conductivity (umhos/cm)	266	2150	3345		307	475	
(remaining data in mg/l except where noted)							
Arsenic	.011	1.100	3.50	1.80	.055	<.005	<.010
Barium	<.100						
Cadmium	<.0005	.0065			.0014		
Chromium	<.005	.140	.094	.076	.050	<.005	<.005
Fluoride (mg/l)	<.0001	62.	160	145	.27	.17	.19
Lead	<.005						
Mercury	<.0002						
Nitrate (mg/l)	1.48	9.6	32	30	.05	8.5	6.3
Nitrite (mg/l)	<0.05	2.9	3.3	33	.24		<.01
Selenium	<.005						
Silver	<.0005						
Iron	6.2						
Manganese	1.7						
Chloride	27						
Sodium	21.5	440	880	850	25	20	21
Sulfate	19	483	980	390	16	25	6
Nickel		.099	.055	.110			
Phenols	<0.01						
TOC	29						
TOX	<0.02	0.185			<.02		
Cyanide (total)		<0.01					
Cyanide (complex)		<0.01			<0.01		
Coliforms (per 100 ml)	<100						
Pesticides/Herbicides	ND						
Radium 226 (pCi/l)	.3 ± .1						
Radium 228 (pCi/l)	.9 ± .9						
Gross Alpha (pCi/l)	.4 ± .3						
Gross Beta (pCi/l)	2.5 ± .8						

NOTES:

1. pH and specific conductance recorded in the field by GZA; remaining analyses performed by Energy Resources Company, Inc. (ERCO) except right hand column of data for 10/10/84, which was performed by Cambridge Analytical Associates, Inc. (CAA).

2. Blank spaces indicate perameter not included in analyses.